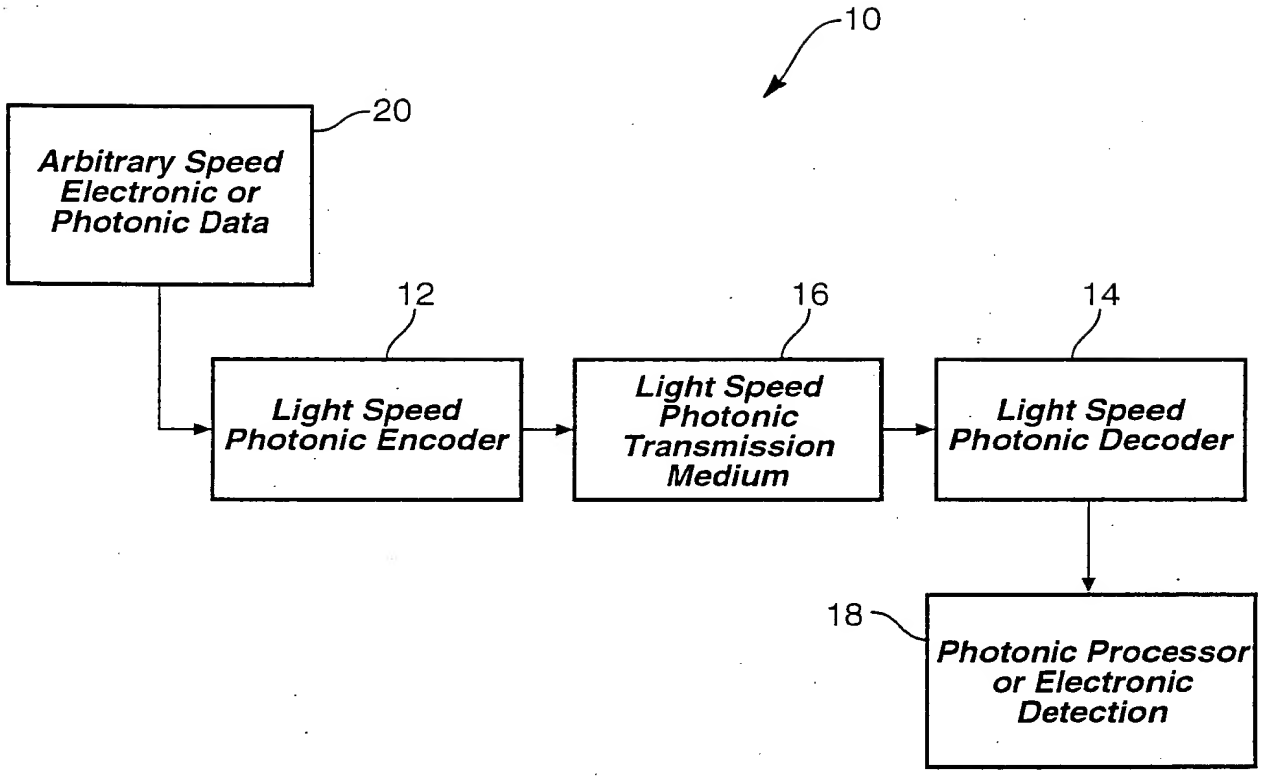

10
20
Arbitrary Speed Electronic or Photonic Data
12
Light Speed Photonic Encoder
16
Light Speed Photonic Transmission Medium
14
Light Speed Photonic Decoder
18
Photonic Processor or Electronic Detection

FIG. 1

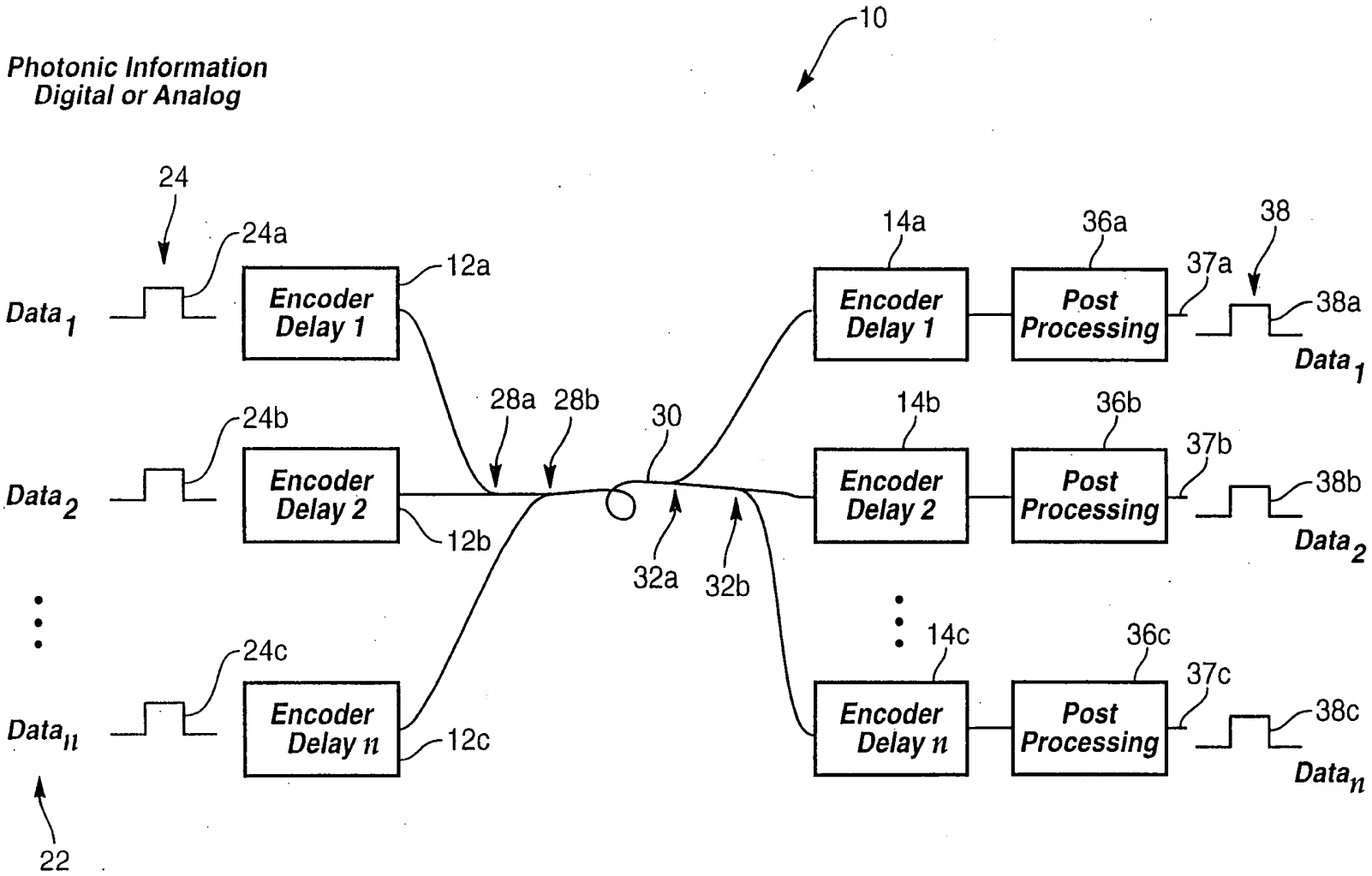
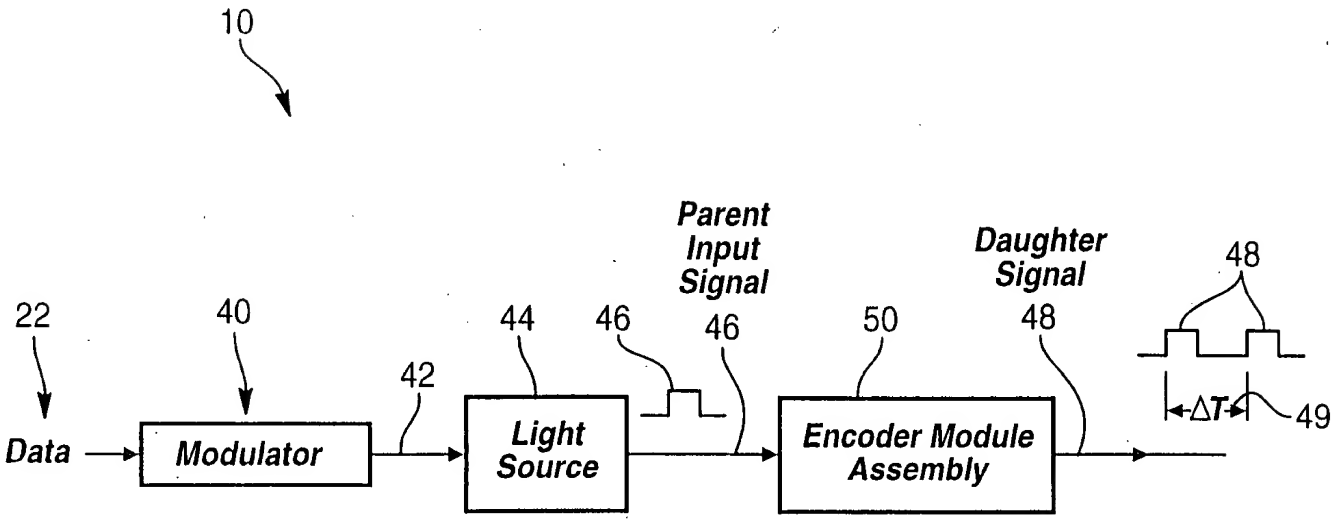
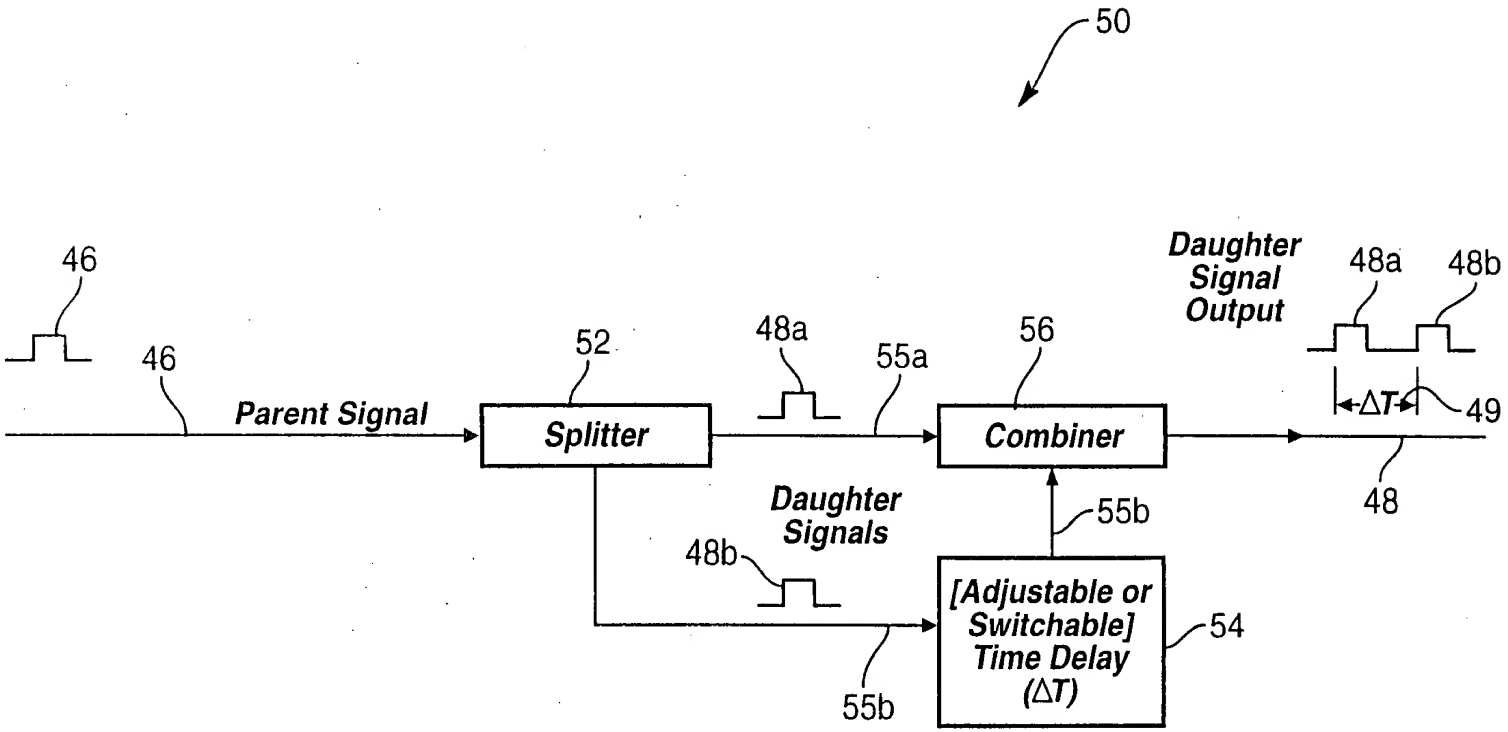

Photonic Information
Digital or Analog
10
24
24a
Data 1
Encoder Delay 1
12a
24b
Data 2
Encoder Delay 2
12b
24c
Data n
Encoder Delay n
12c
22
28a
28b
30
32a
32b
14a
Encoder Delay 1
36a
Post Processing
37a
38
38a
Data 1
14b
Encoder Delay 2
36b
Post Processing
37b
38b
Data 2
14c
Encoder Delay n
36c
Post Processing
37c
38c
Data n

Fig. 2



Differential Delay Multiplexer Sender/Encoder

Fig. 3



Differential Delay Multiplexer (DDM) Sender/Encoder

Fig. 4

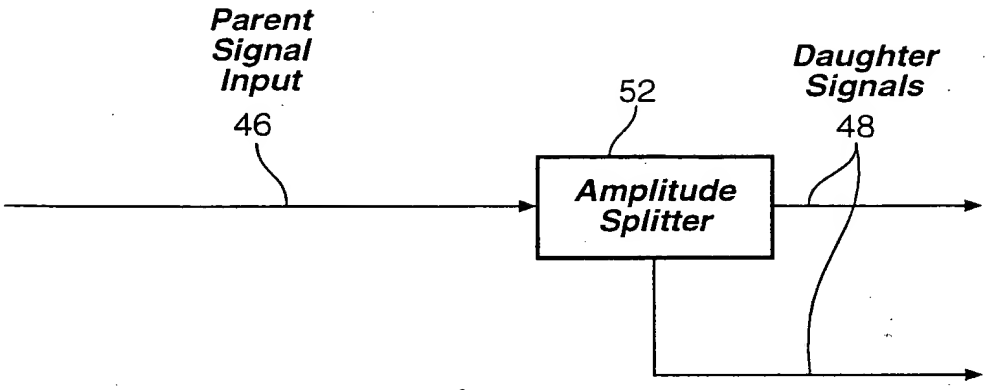
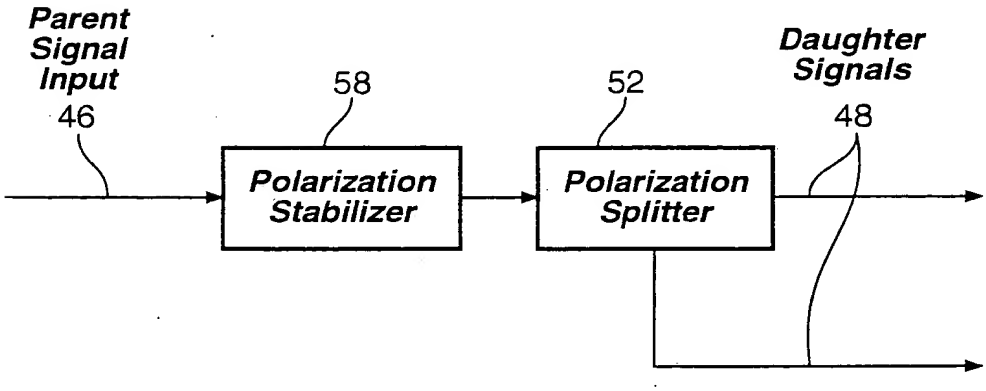
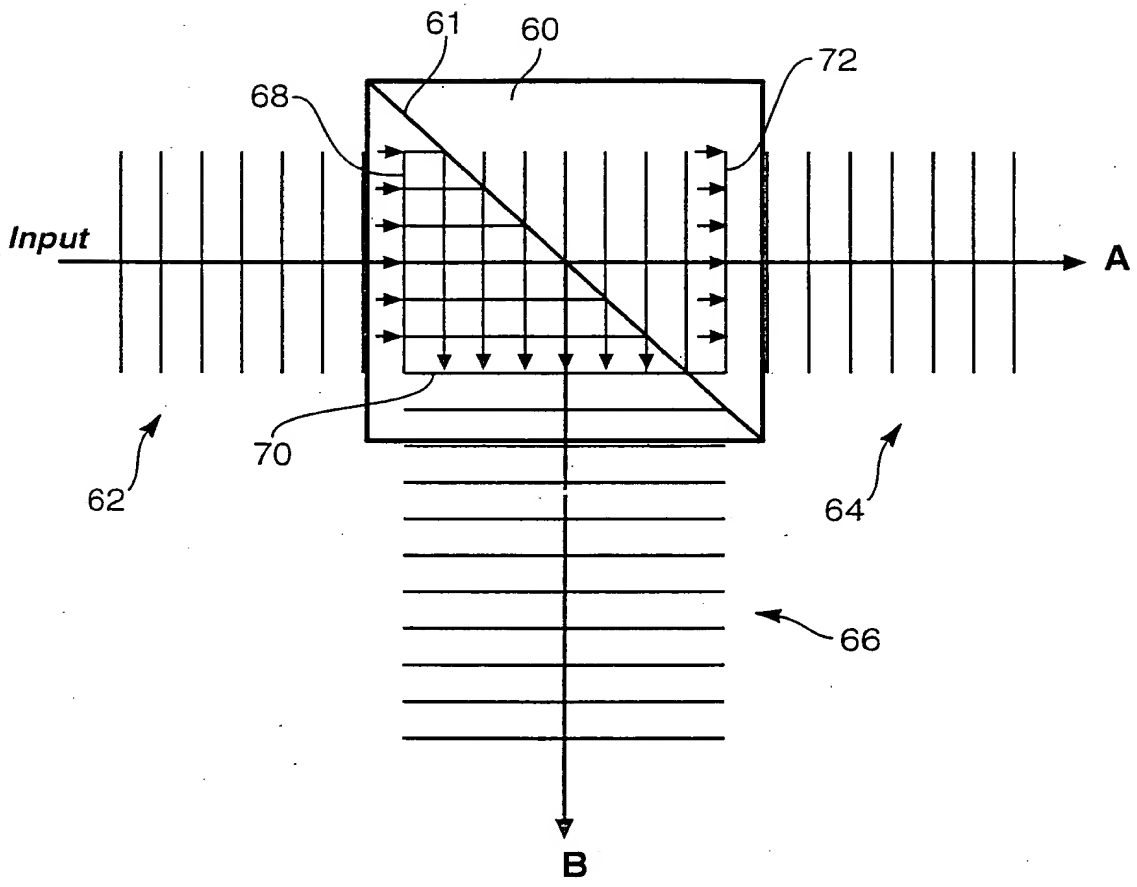


FIG. 5



Splitting Criteria

FIG. 6



Amplitude or Polarization Splitter

FIG. 7

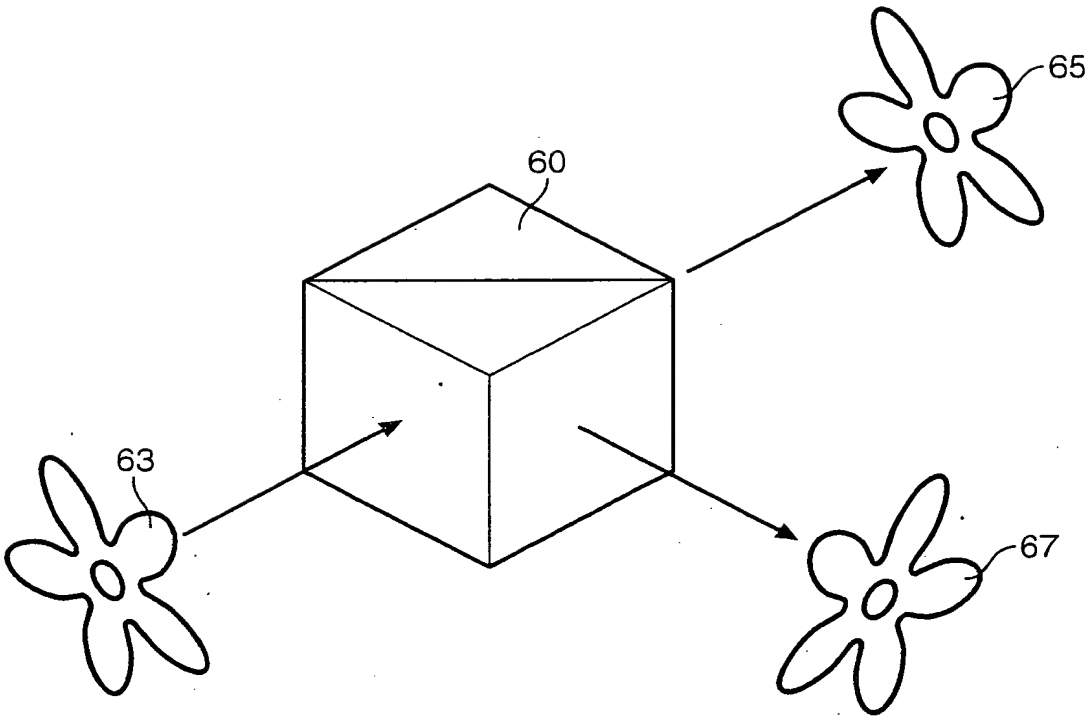
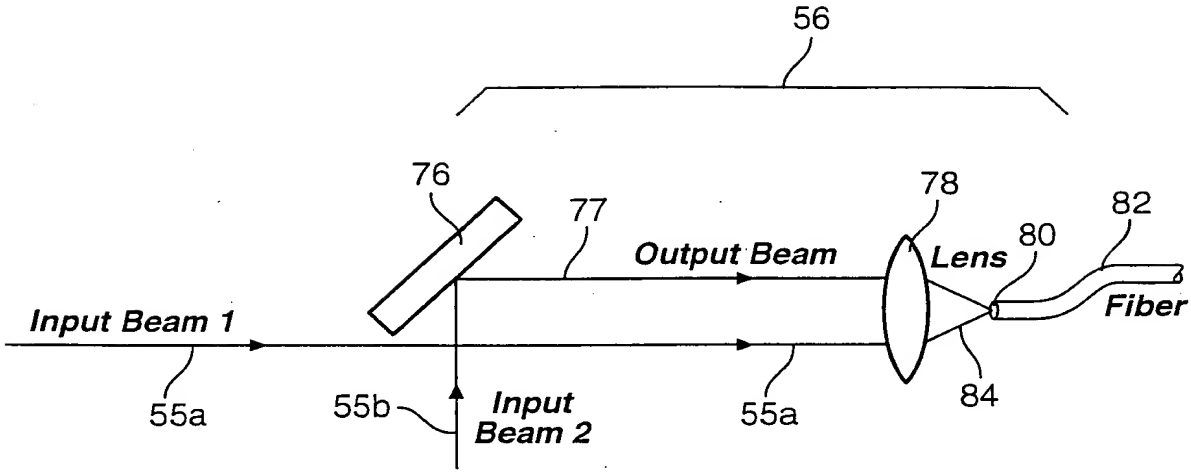


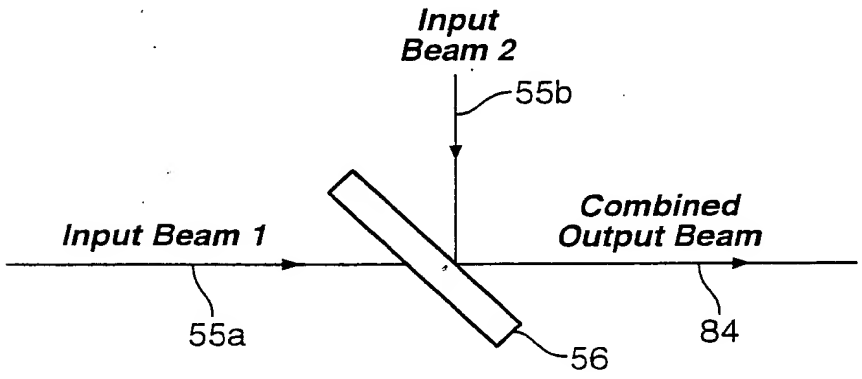
Image Signals Which
Maintain Spatial Information

FIG. 7A



Beam Combiner

FIG. 8



Amplitude or Polarization Combiner

FIG. 9

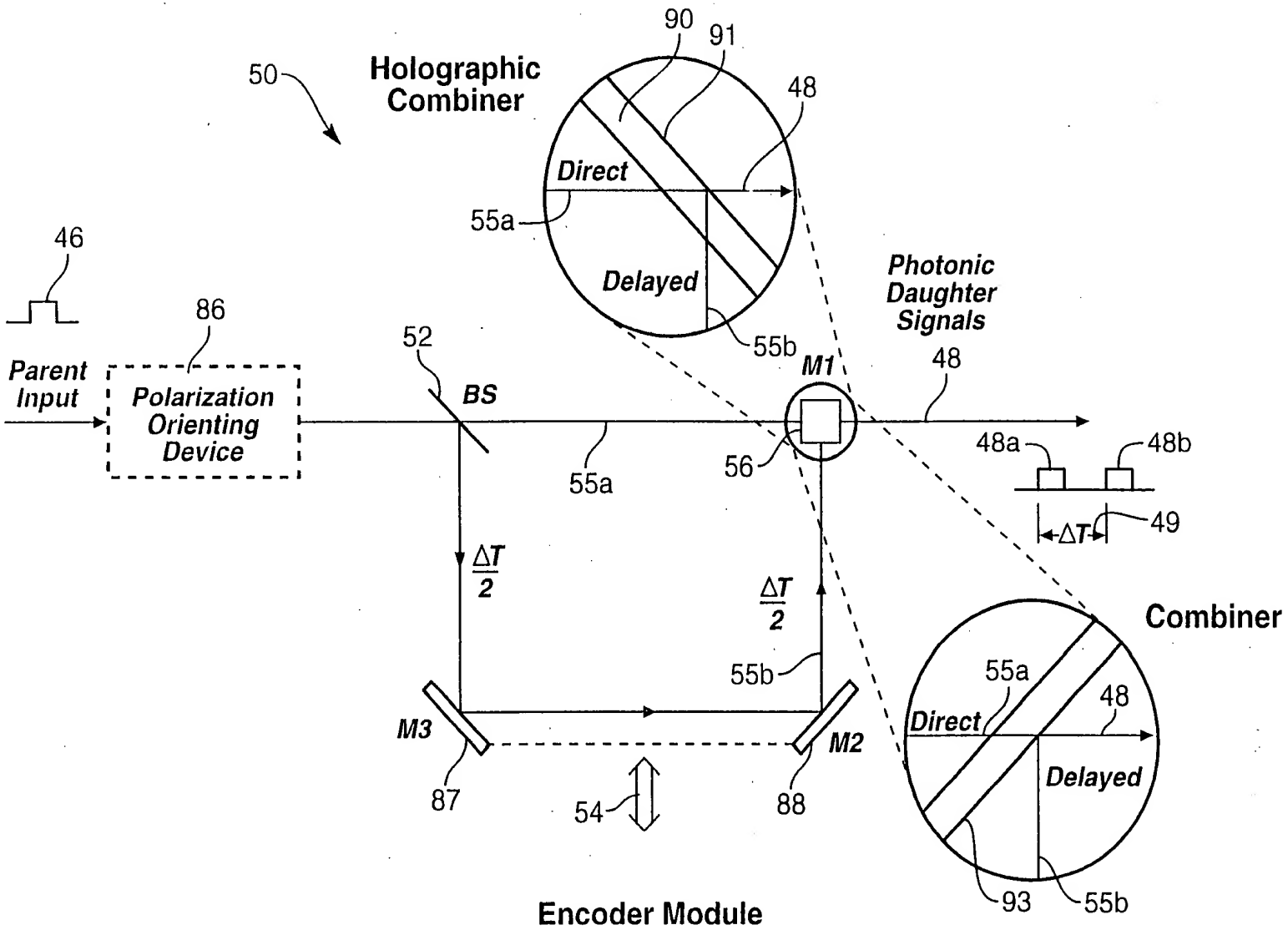
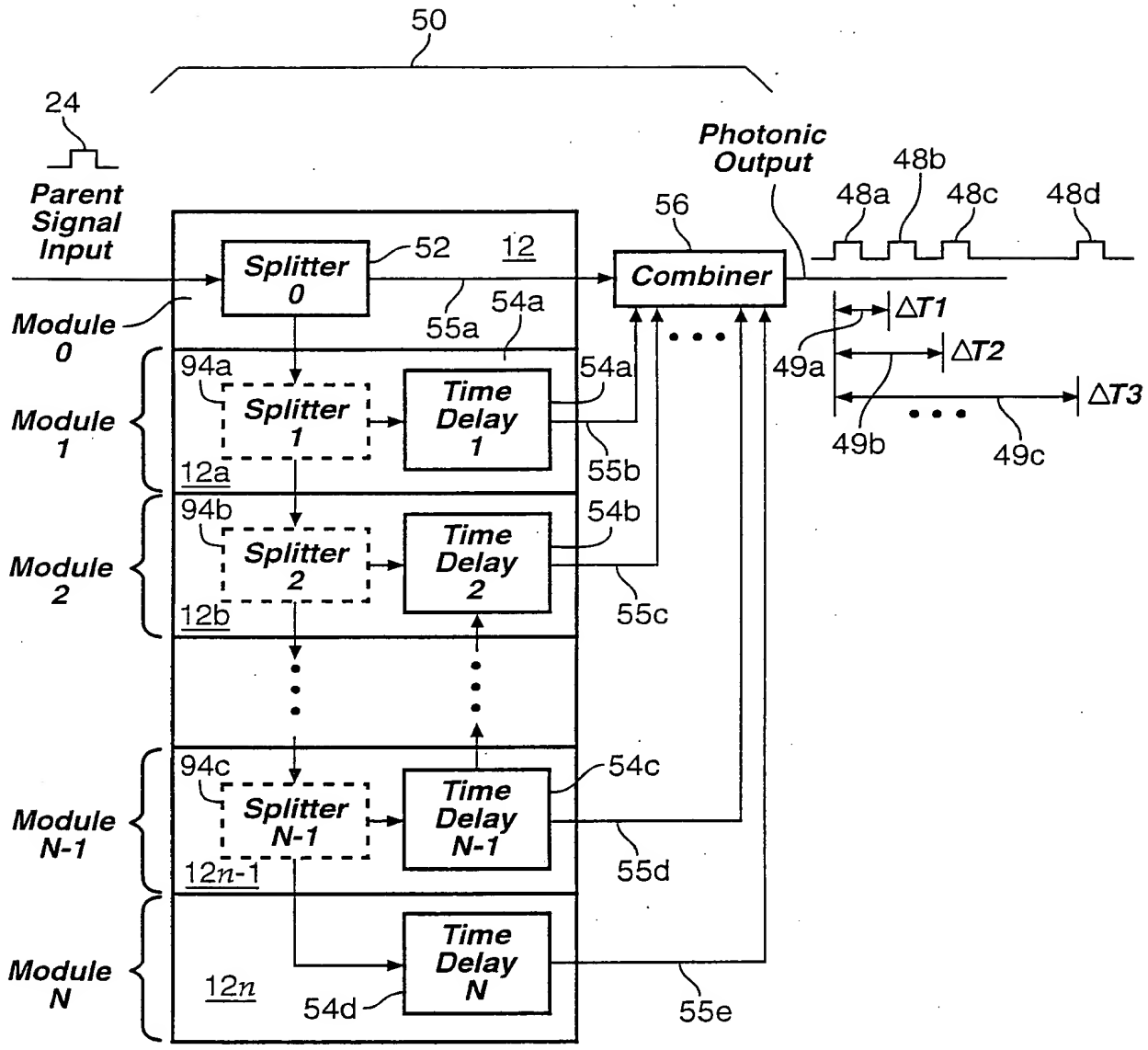

50
Holographic Combiner
90
91
48
Direct
55a
Delayed
55b
46
86
Parent Input
Polarization Orienting Device
52
BS
M1
Photonic Daughter Signals
48
48a
48b
49
ΔT
56
55a
ΔT/2
ΔT/2
55b
M3
M2
87
54
88
Combiner
55a
48
Direct
Delayed
93
55b
Encoder Module

Fig. 10



Composite Encoder Module Assembly

FIG. 11

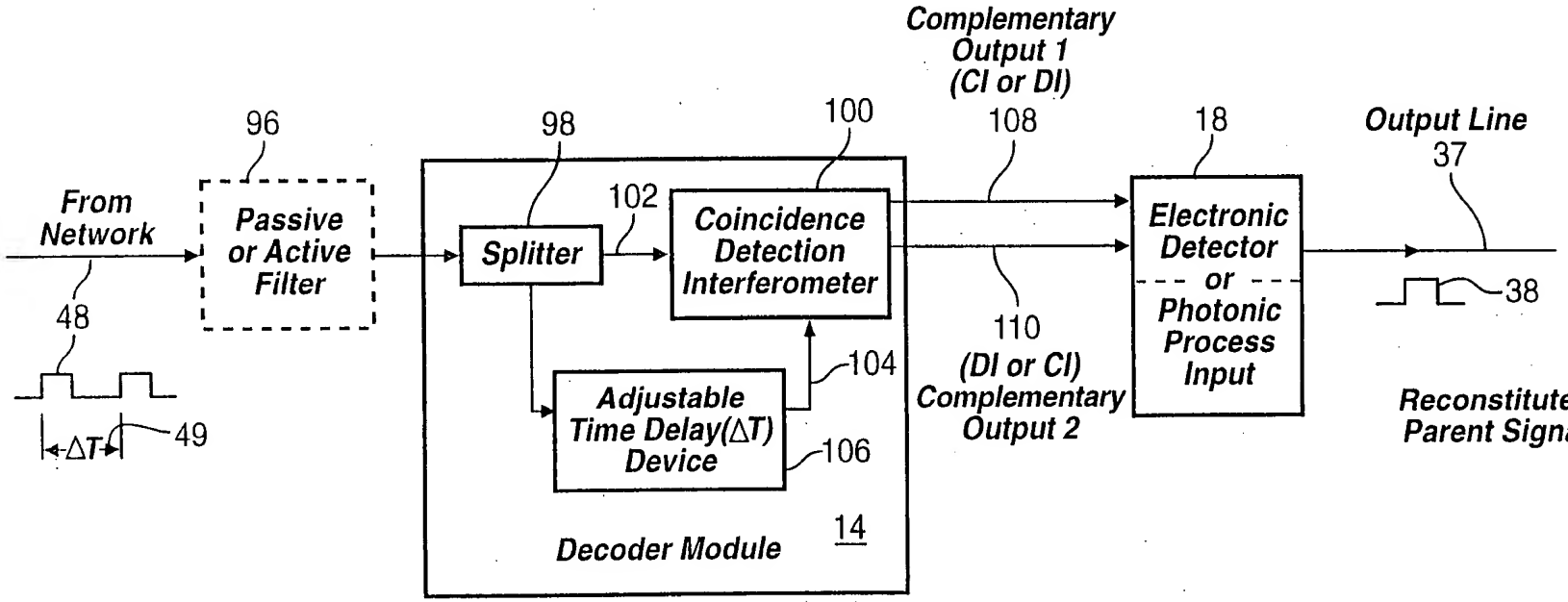

From Network
48
ΔT
49
96
Passive or Active Filter
98
Splitter
102
100
Coincidence Detection Interferometer
104
Adjustable Time Delay(ΔT) Device
106
Decoder Module
14
Complementary Output 1 (CI or DI)
108
110
(DI or CI) Complementary Output 2
18
Electronic Detector
or
Photonic Process Input
Output Line
37
38
Reconstituted Parent Signal

Fig. 12

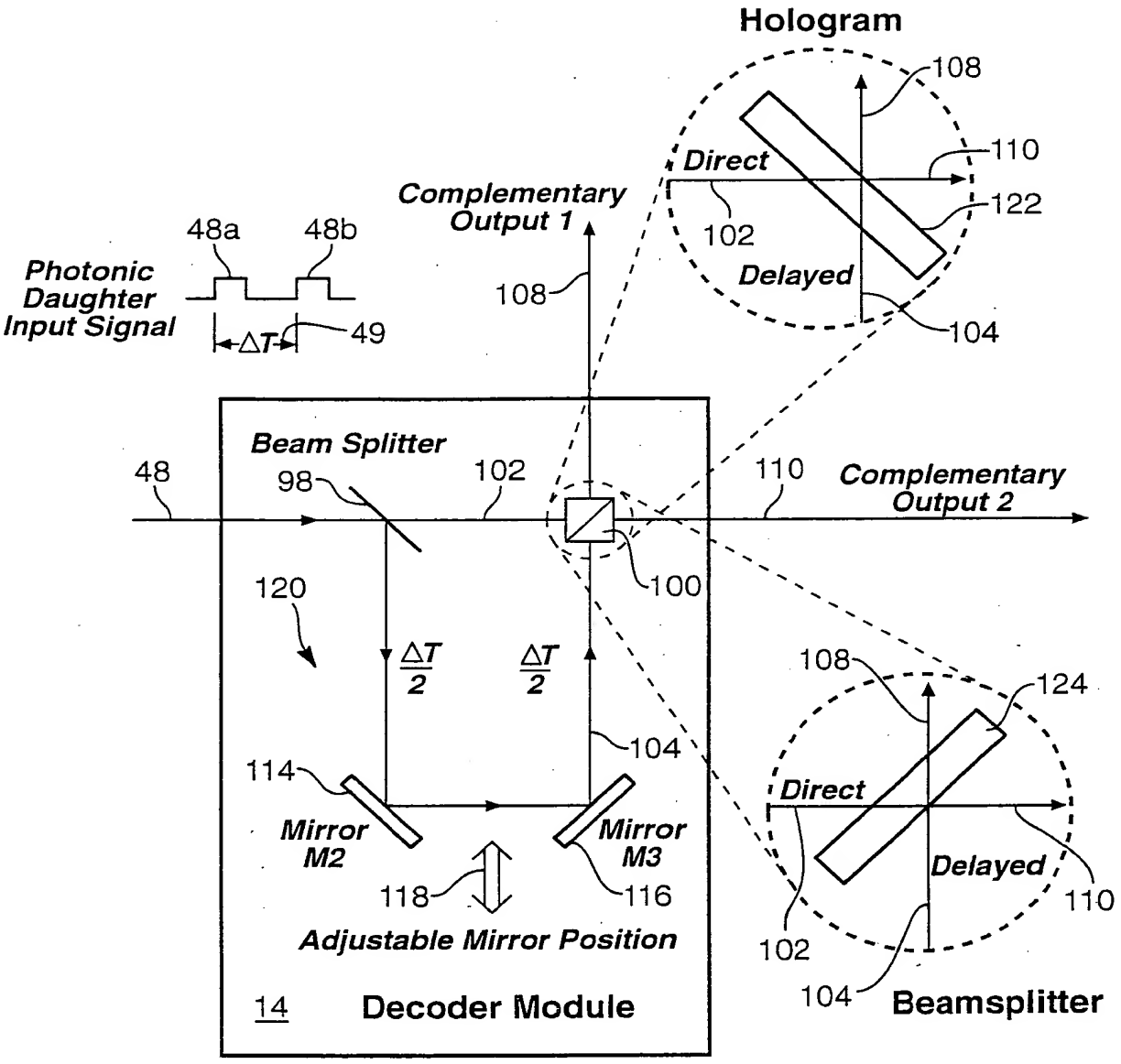

Hologram
108
110
Direct
122
Complementary Output 1
102
Delayed
104
48a
48b
Photonic Daughter Input Signal
ΔT
49
108
Beam Splitter
48
98
102
110
Complementary Output 2
100
120
ΔT/2
ΔT/2
108
124
104
114
Direct
Mirror M2
Mirror M3
118
116
Delayed
110
102
Adjustable Mirror Position
104
Beamsplitter
14
Decoder Module

FIG. 13

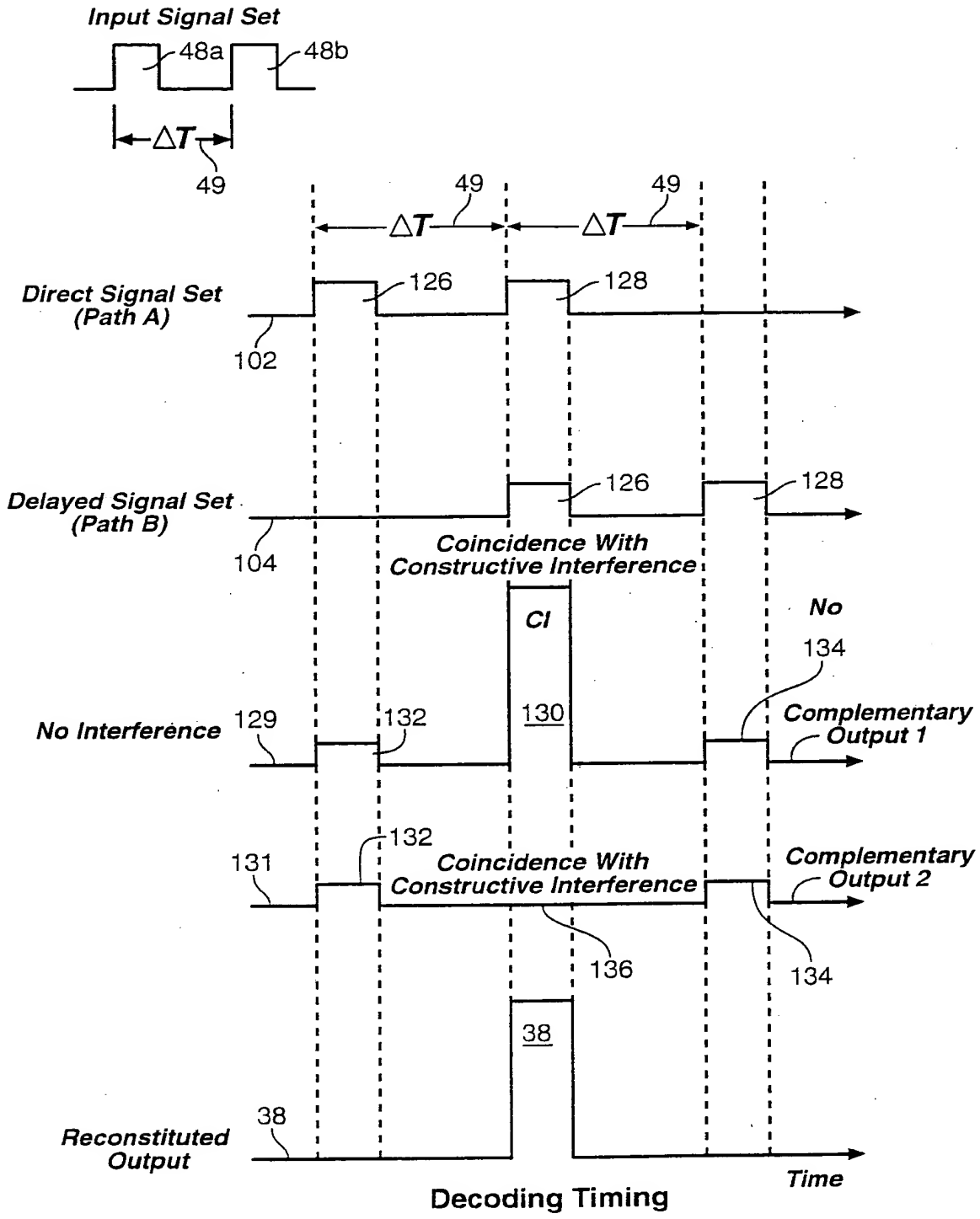

Input Signal Set
48a
48b
ΔT
49
49
49
ΔT
ΔT
Direct Signal Set
(Path A)
126
128
102
Delayed Signal Set
(Path B)
126
128
104
Coincidence With
Constructive Interference
CI
No
134
No Interference
129
132
130
Complementary
Output 1
132
131
Coincidence With
Constructive Interference
Complementary
Output 2
136
134
38
38
Reconstituted
Output
Time
Decoding Timing

FIG. 14

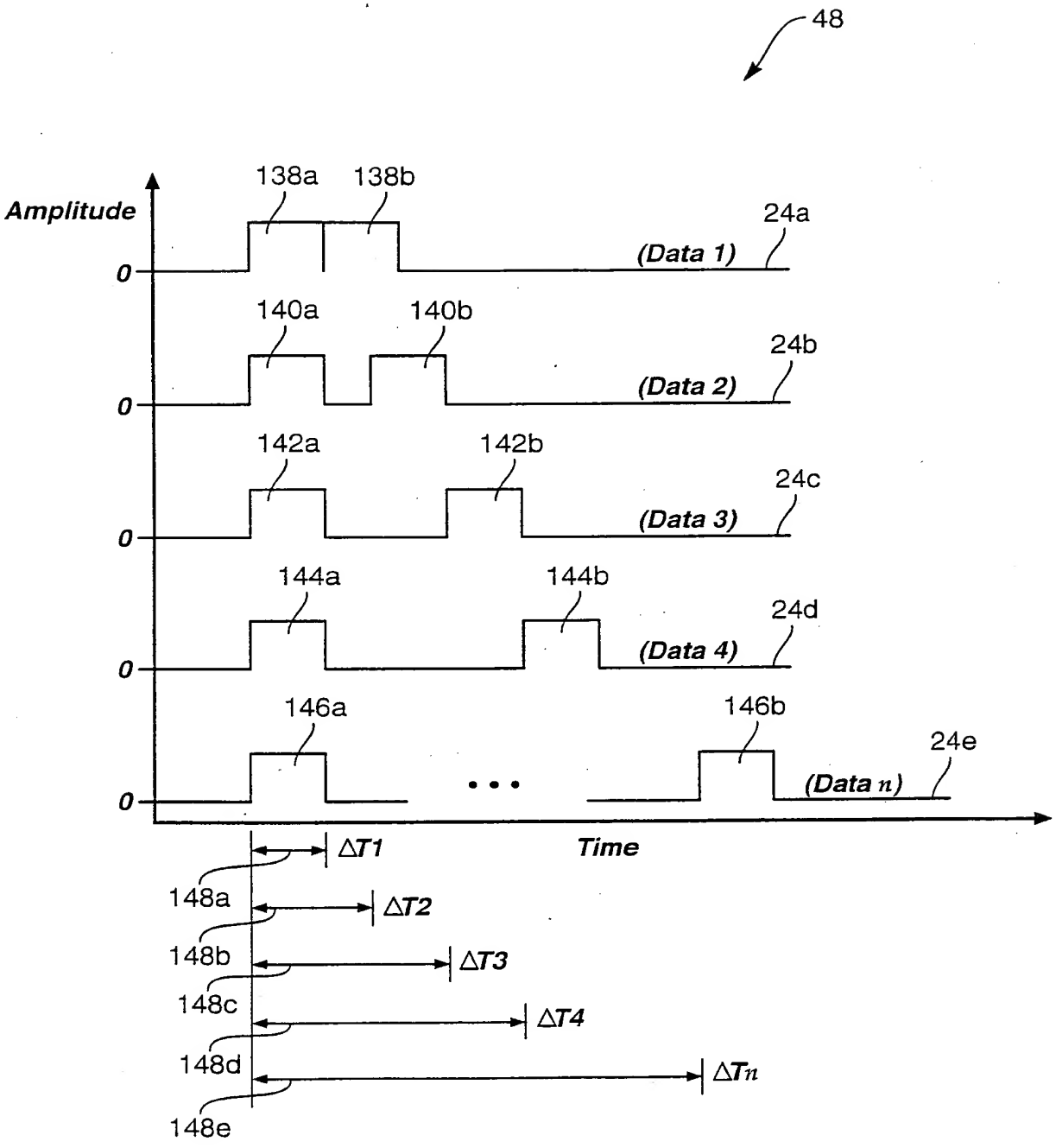

48
Amplitude
0
138a
138b
24a
(Data 1)
140a
140b
24b
(Data 2)
142a
142b
24c
(Data 3)
144a
144b
24d
(Data 4)
146a
146b
24e
(Data n)
Time
ΔT1
148a
ΔT2
148b
ΔT3
148c
ΔT4
148d
ΔTn
148e

Fig. 15

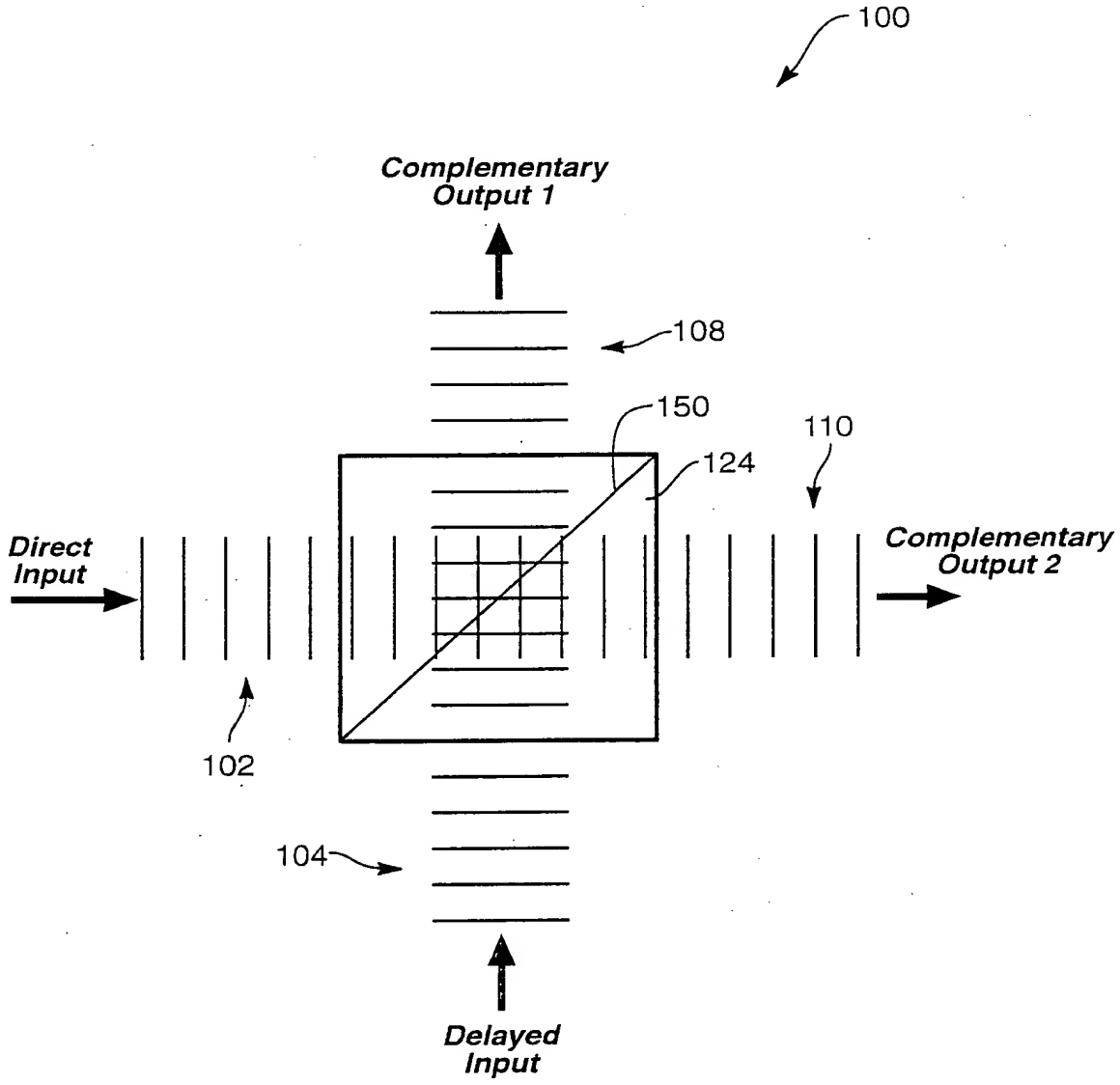

100
Complementary Output 1
108
150
110
124
Direct Input
Complementary Output 2
102
104
Delayed Input

Fig. 16

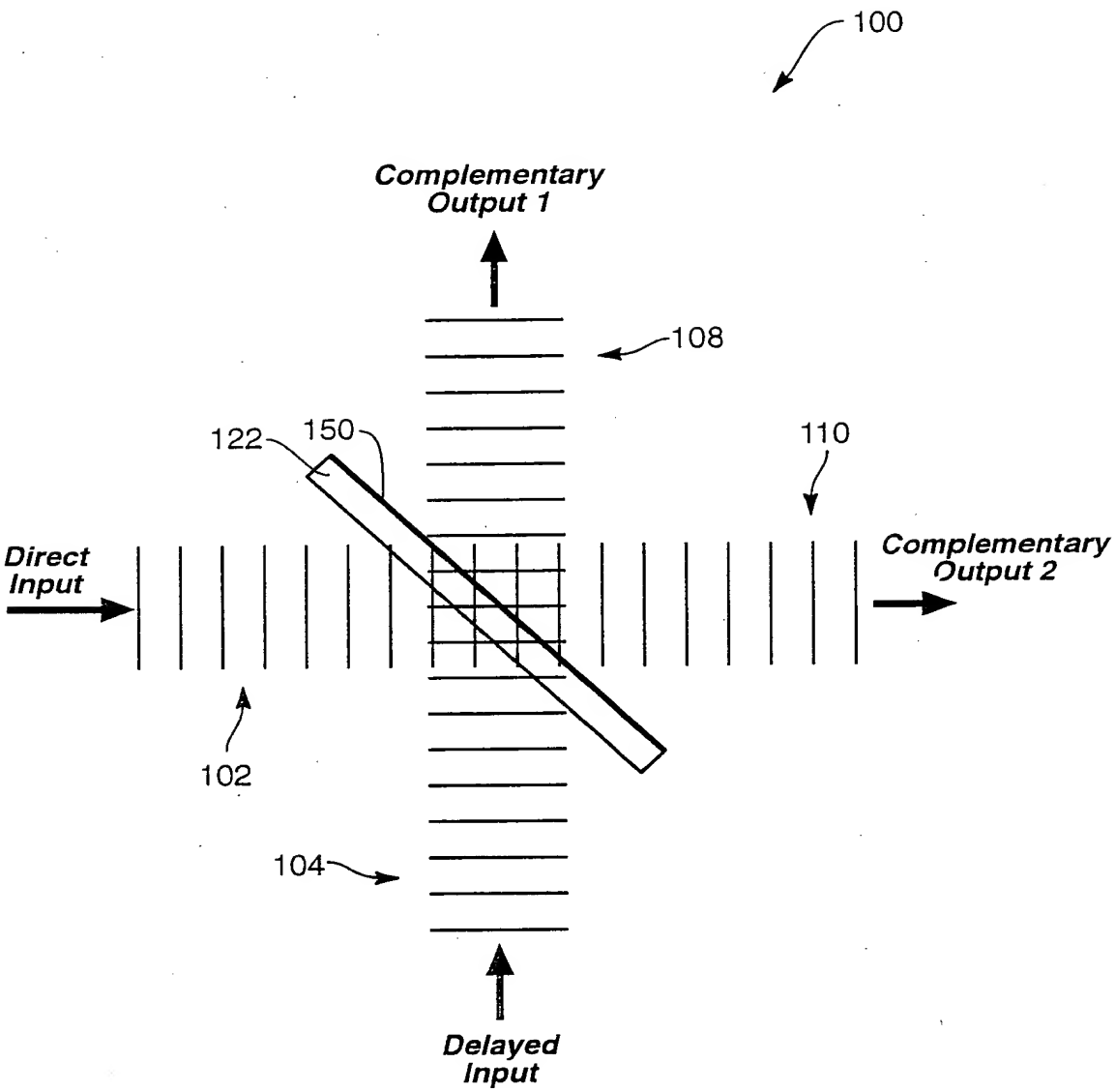

100
Complementary Output 1
108
122
150
110
Direct Input
Complementary Output 2
102
104
Delayed Input

Fig. 17

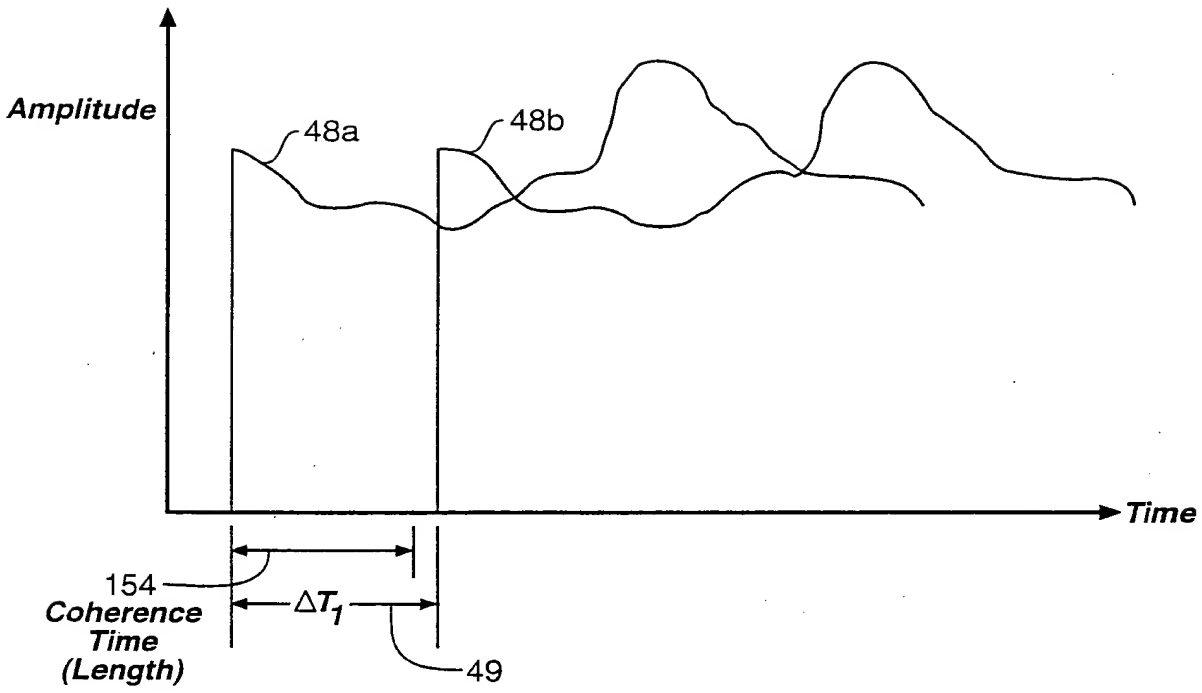

Amplitude
48a
48b
Time
154
Coherence
Time
(Length)
ΔT_1
49

Fig. 18

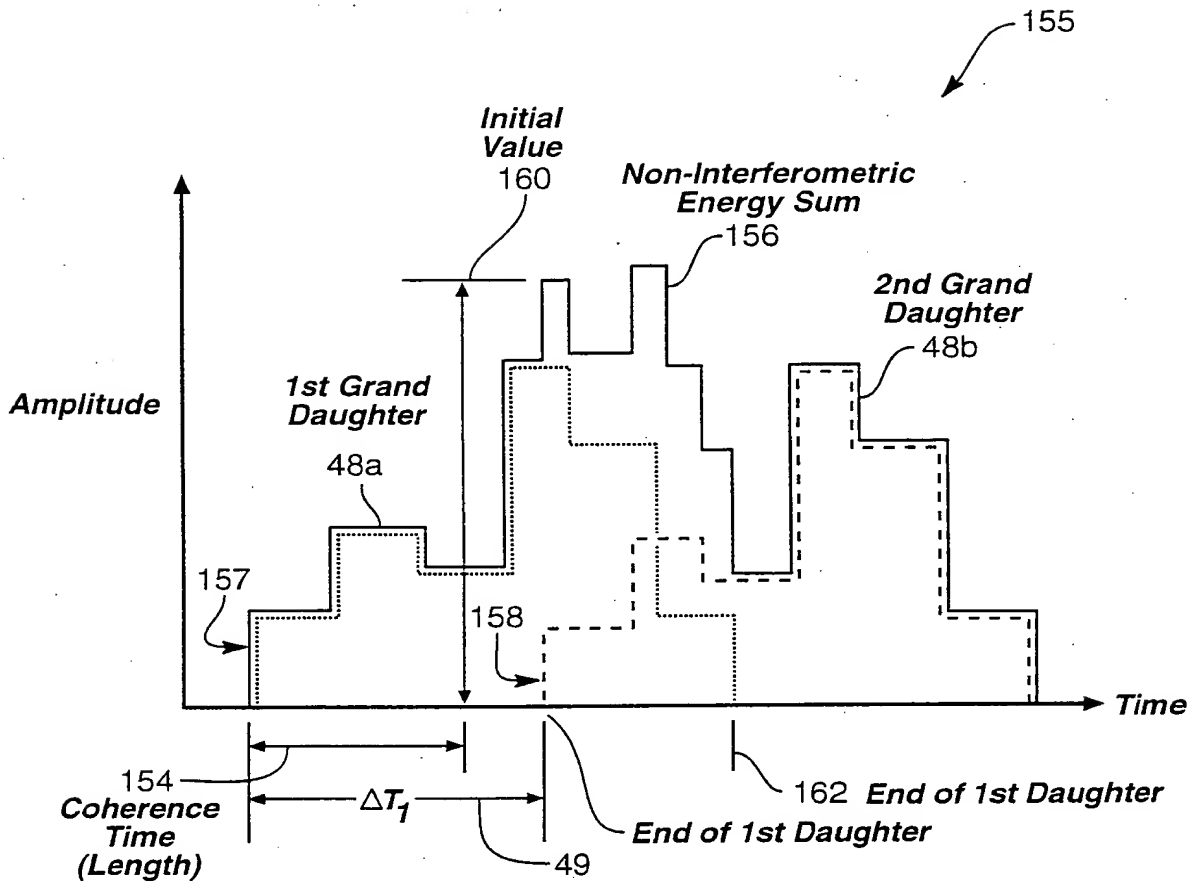

155
Initial Value
160
Non-Interferometric Energy Sum
156
2nd Grand Daughter
48b
Amplitude
1st Grand Daughter
48a
157
158
Time
154
Coherence Time (Length)
ΔT_1
162 End of 1st Daughter
End of 1st Daughter
49

Fig. 19

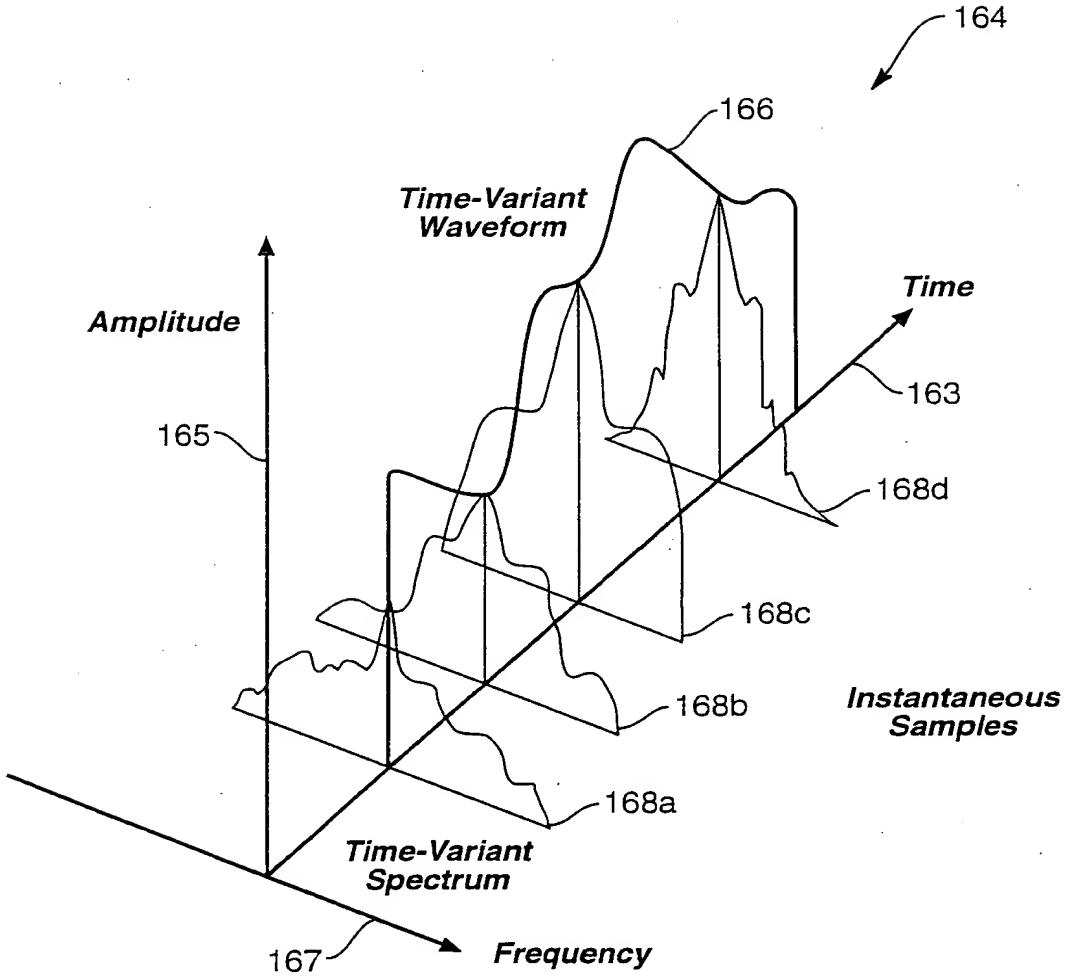

164
166
Time-Variant
Waveform
Amplitude
Time
163
165
168d
168c
168b
Instantaneous
Samples
168a
Time-Variant
Spectrum
167
Frequency

Fig. 20

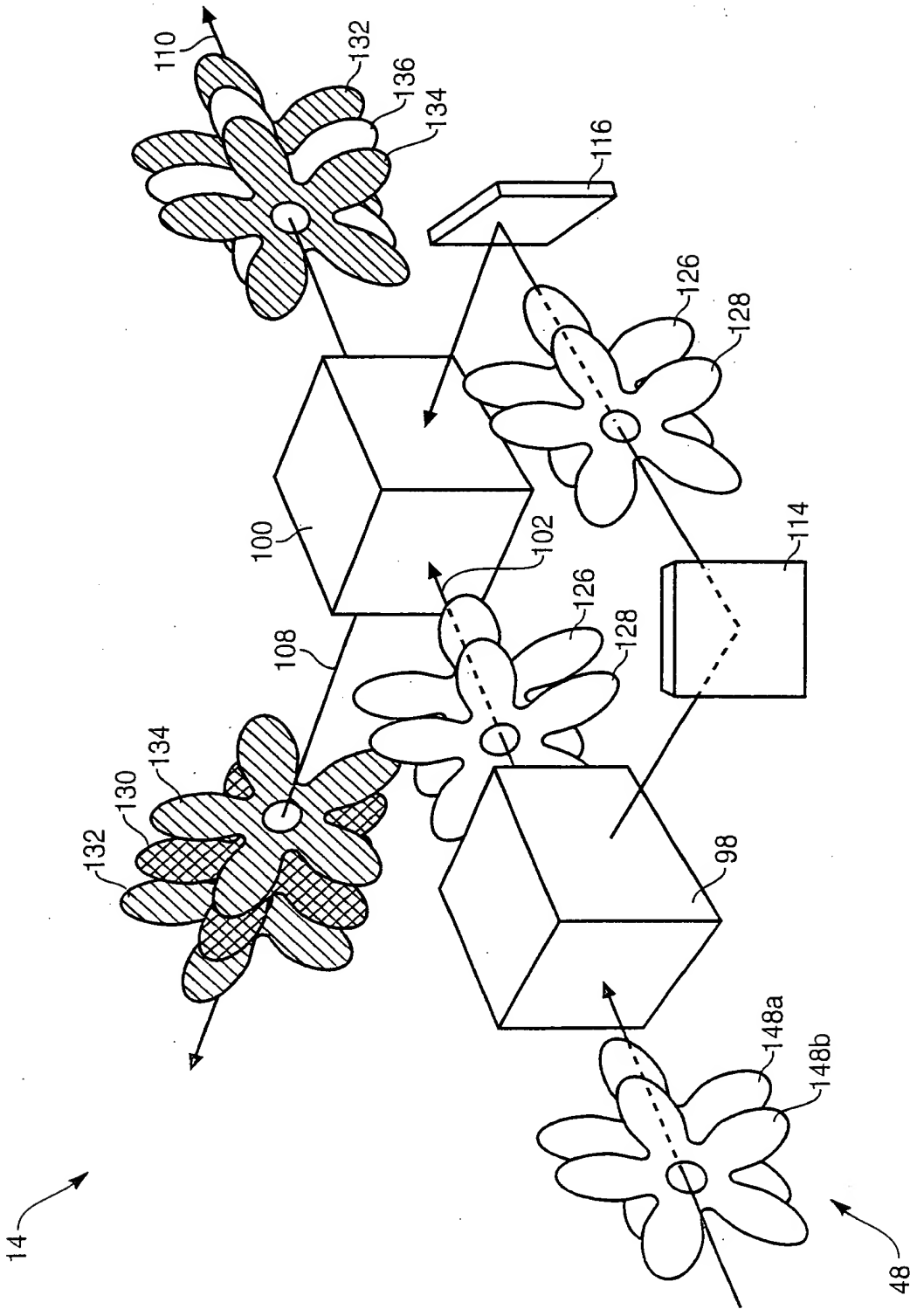
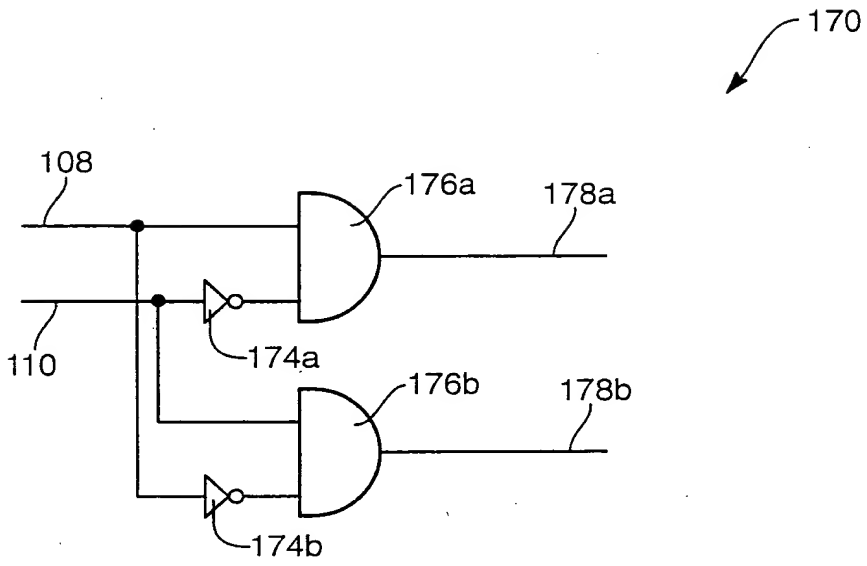
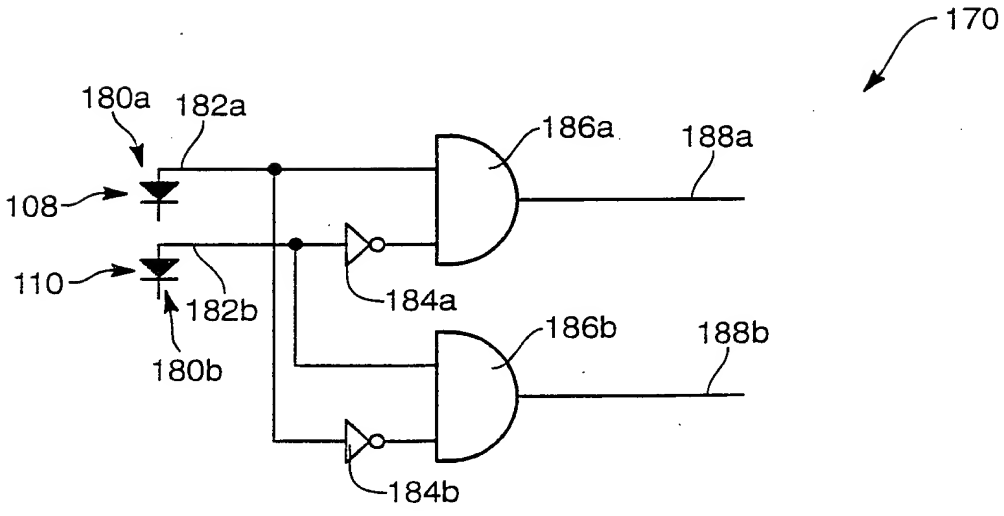

14
110
132
136
134
116
126
128
100
102
108
126
128
114
132
130
134
98
148a
148b
48

Fig. 21



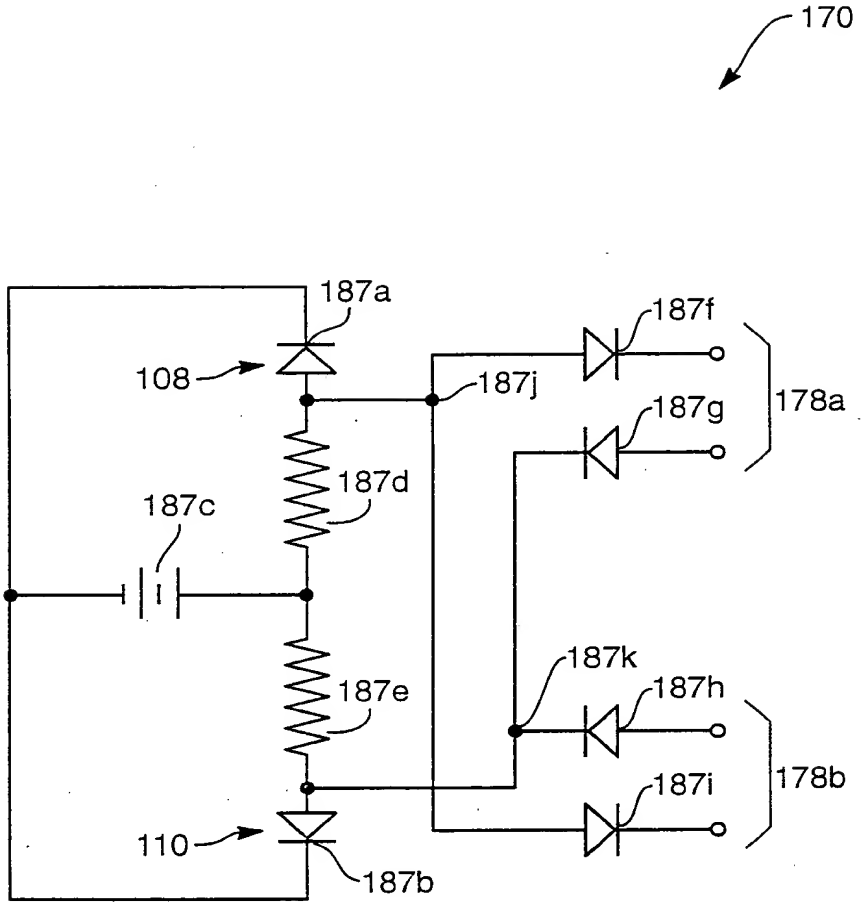
Photonic Processor

Fig. 22



Electronic Processor

Fig. 23A



Electronic Processor

Fig. 23B

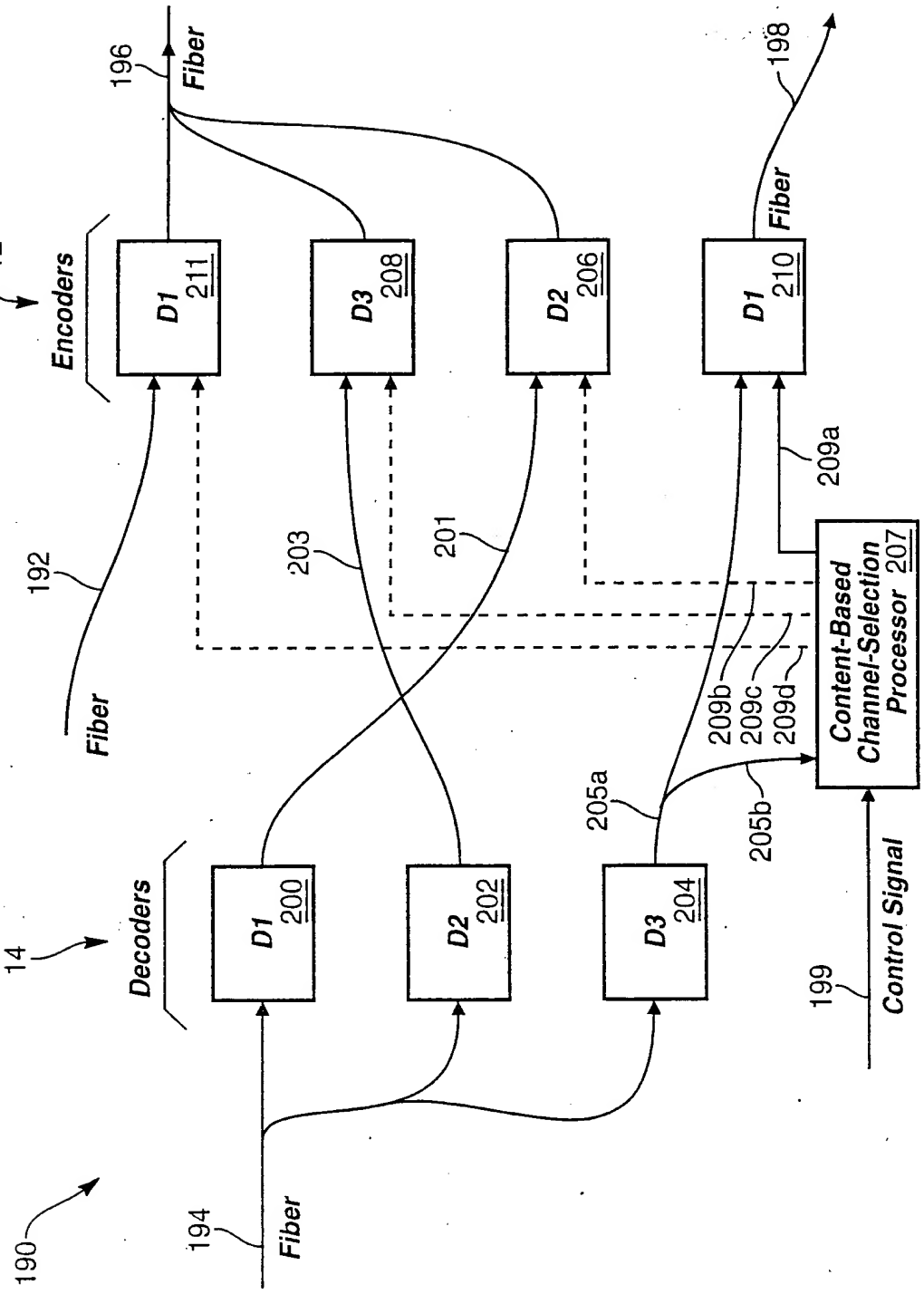
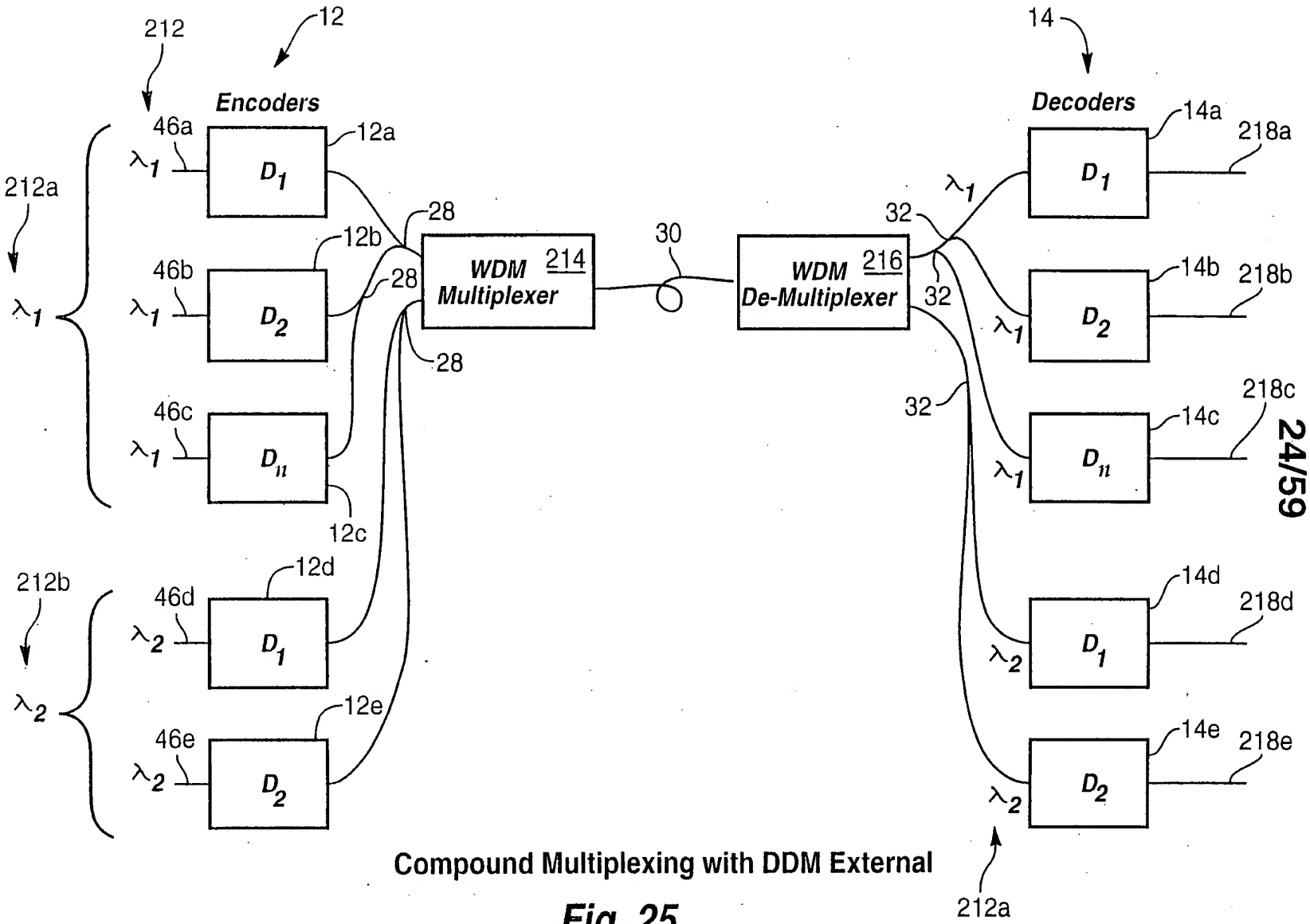

190
194
Fiber
14
Decoders
D1 200
D2 202
D3 204
205a
205b
199
Control Signal
Content-Based Channel-Selection Processor 207
209a
209b
209c
209d
201
203
192
Fiber
12
Encoders
D1 211
D3 208
D2 206
D1 210
196
Fiber
198
Fiber
Drop/Rearrange/Add
Unbuilding/Rebuilding

Fig. 24



Compound Multiplexing with DDM External

Fig. 25

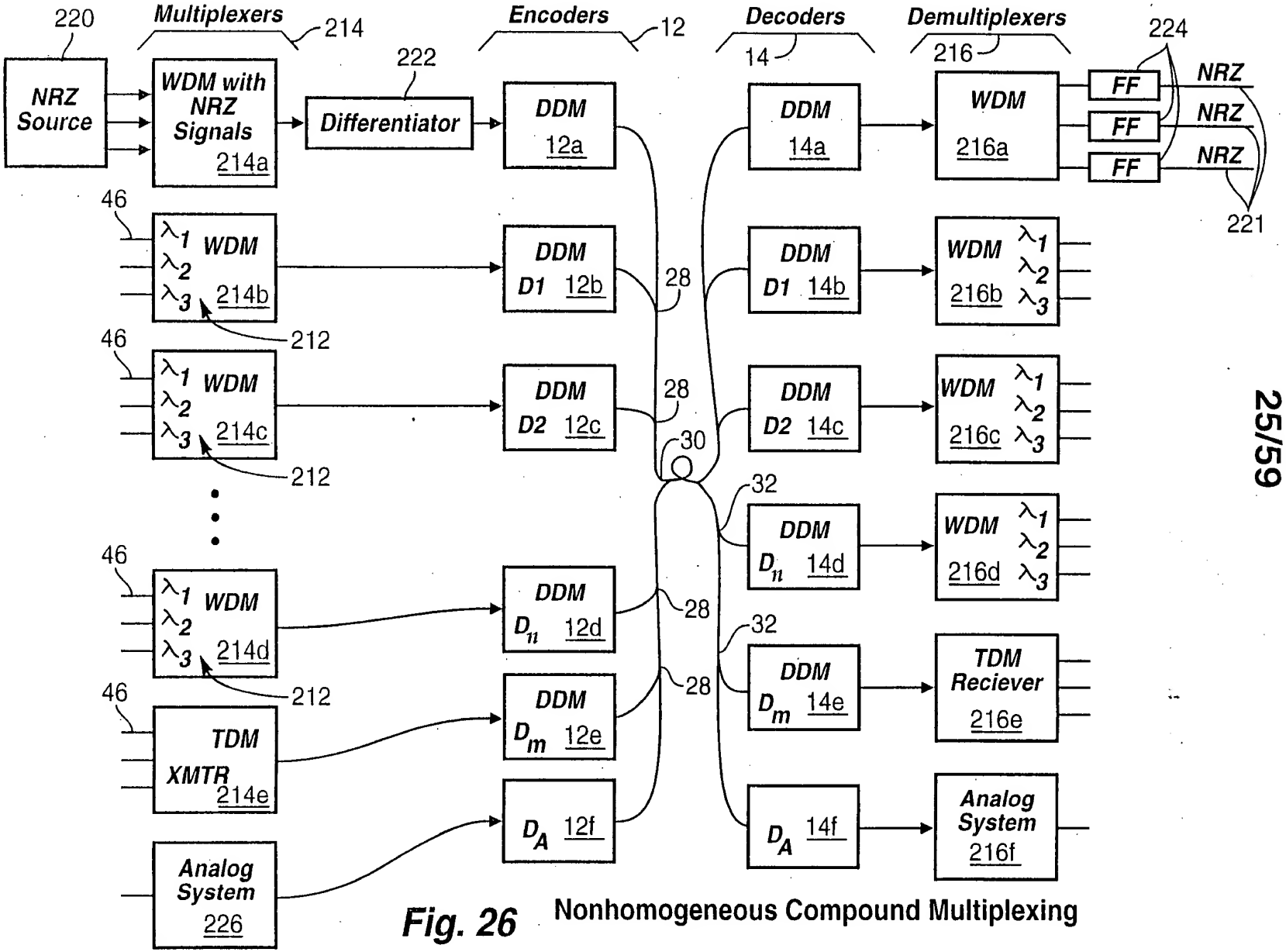
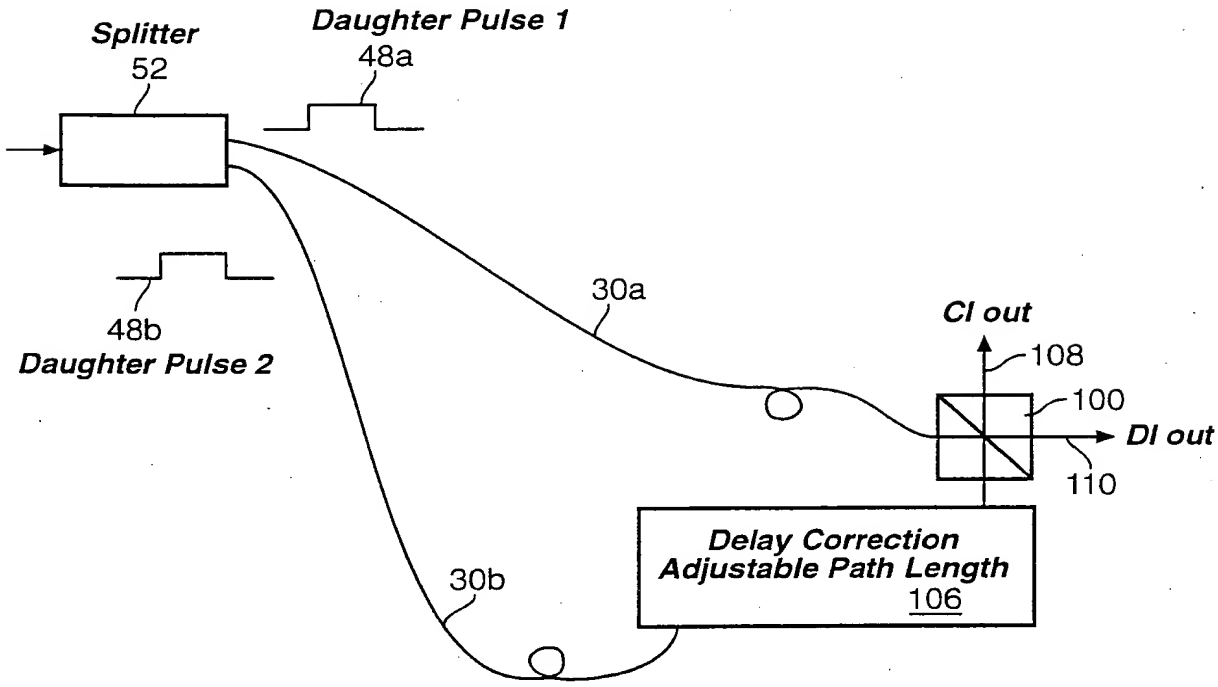


Fig. 26 Nonhomogeneous Compound Multiplexing



Multiple Delay Path

Integrated Delay and
Delay Correction

FIG. 27

Photonic NRZ Interface

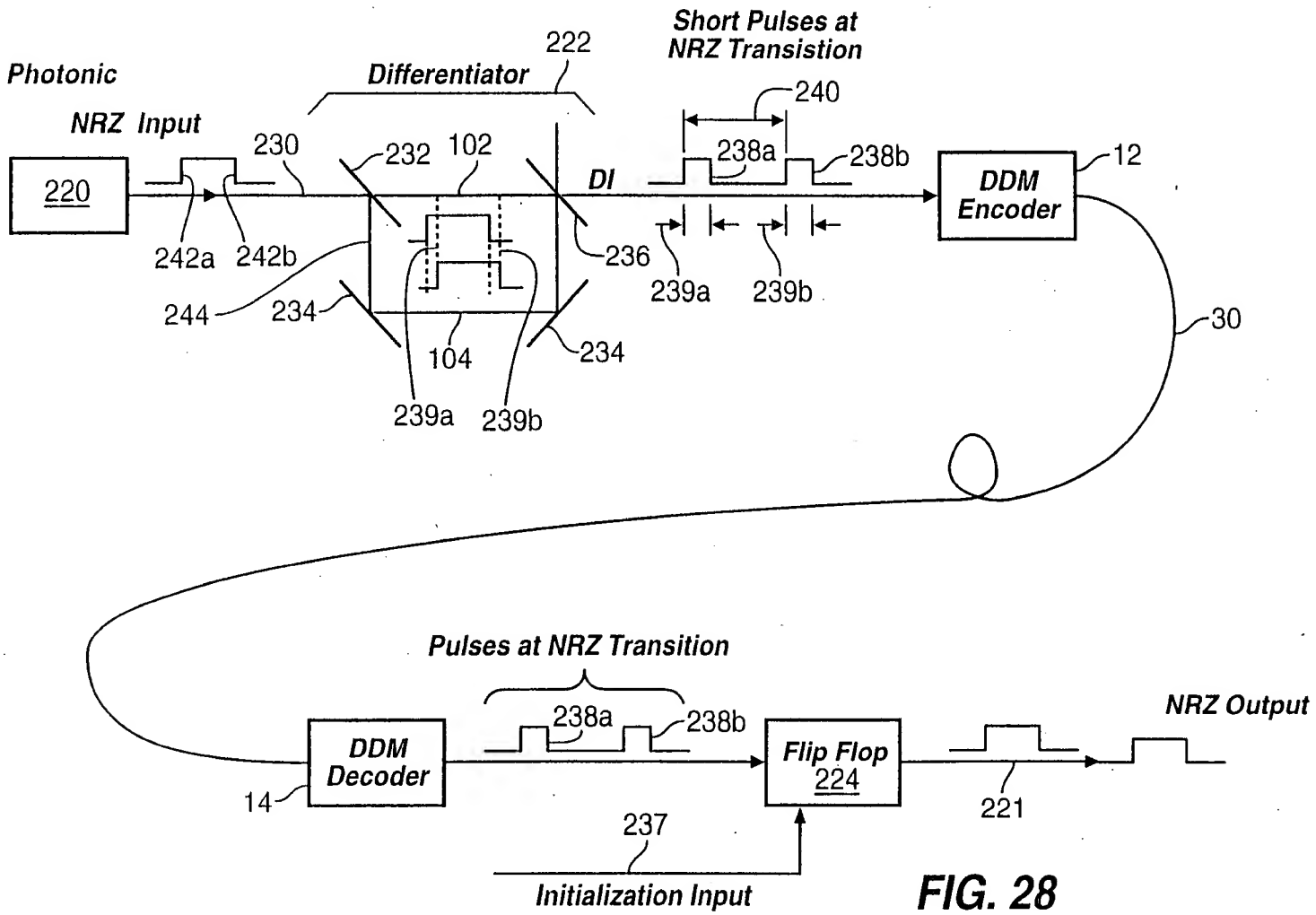


FIG. 28

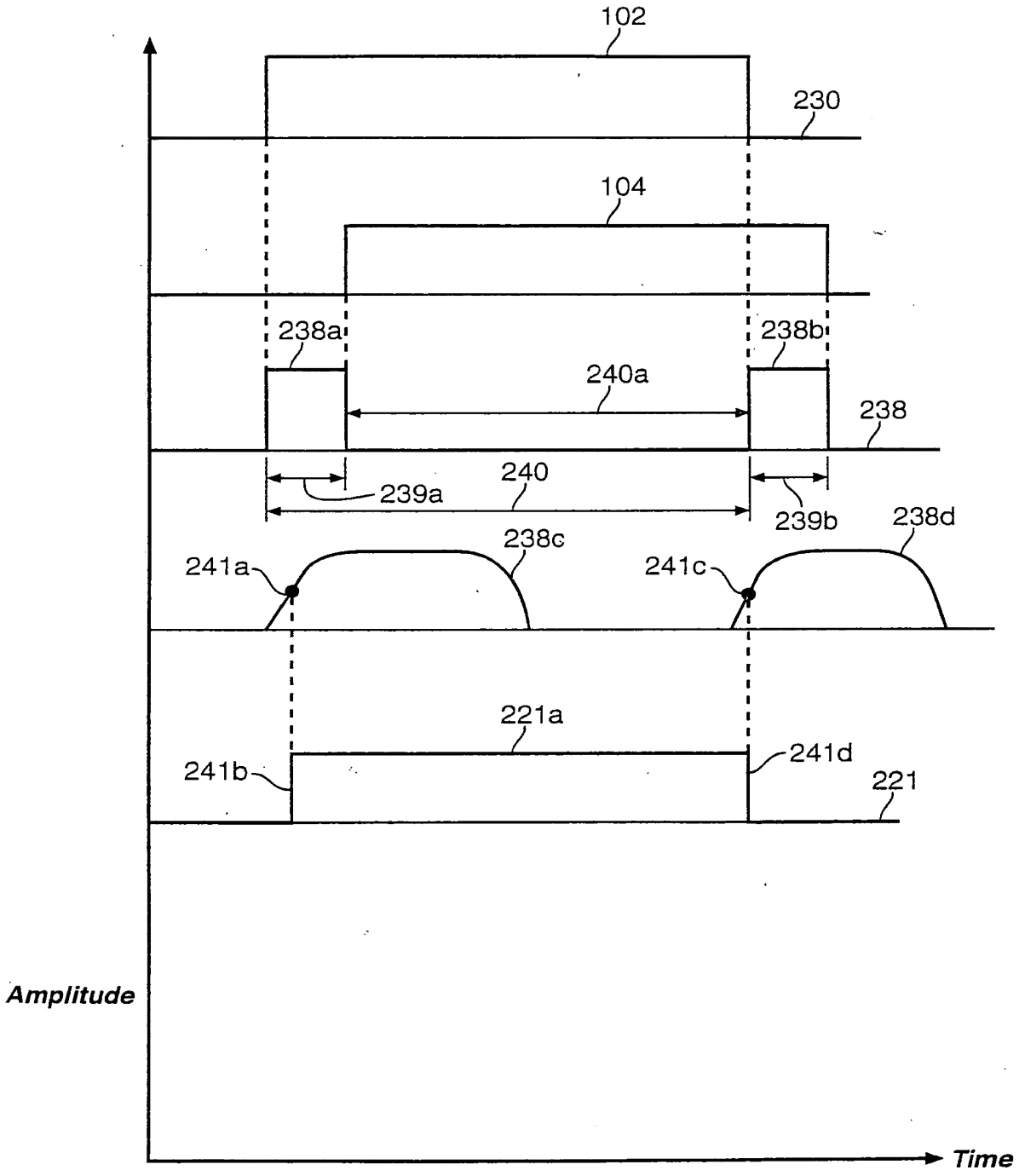
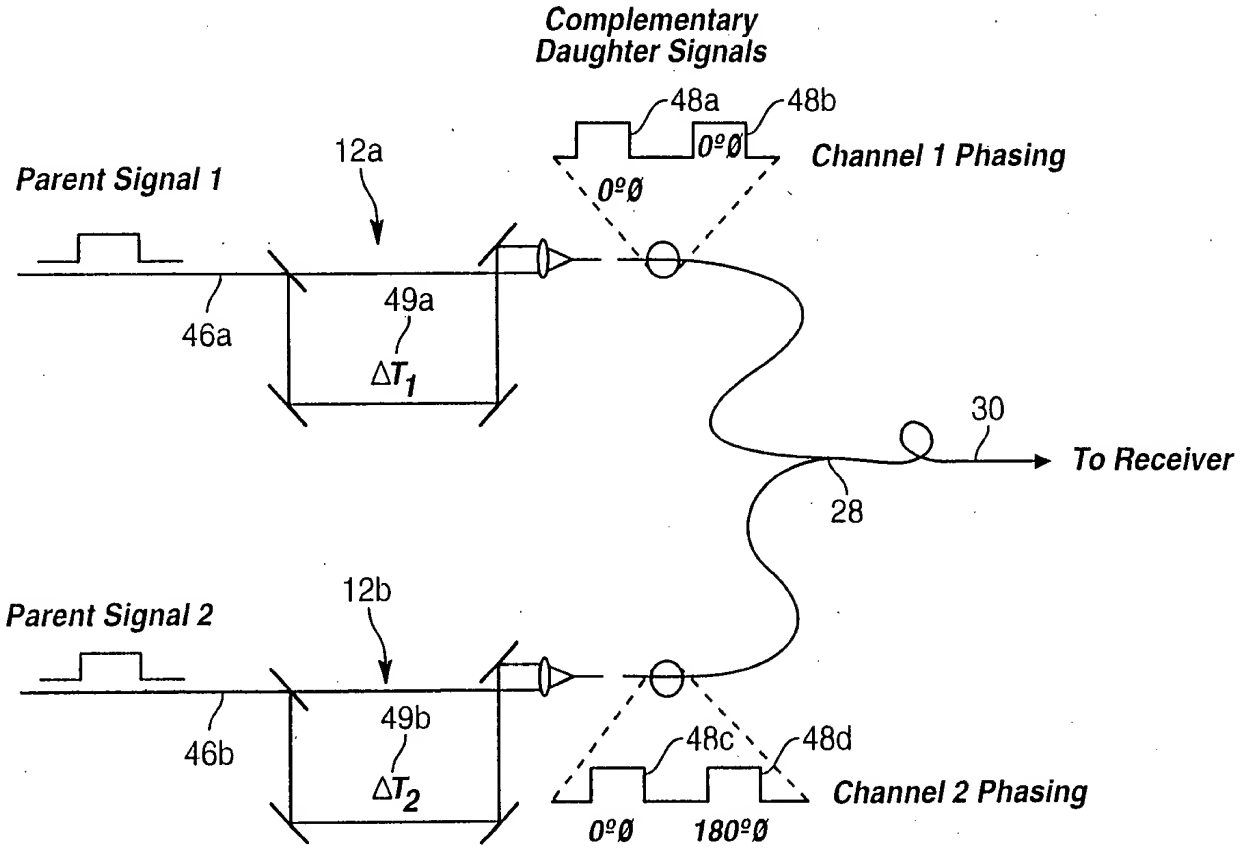

102
230
104
238a
238b
240a
238
240
239a
239b
238d
238c
241a
241c
221a
241b
241d
221
Amplitude
Time

FIG. 29



Phase Sequenced Dual Channel Encoder

FIG. 30

Phase Sequenced Dual Channel Decoder

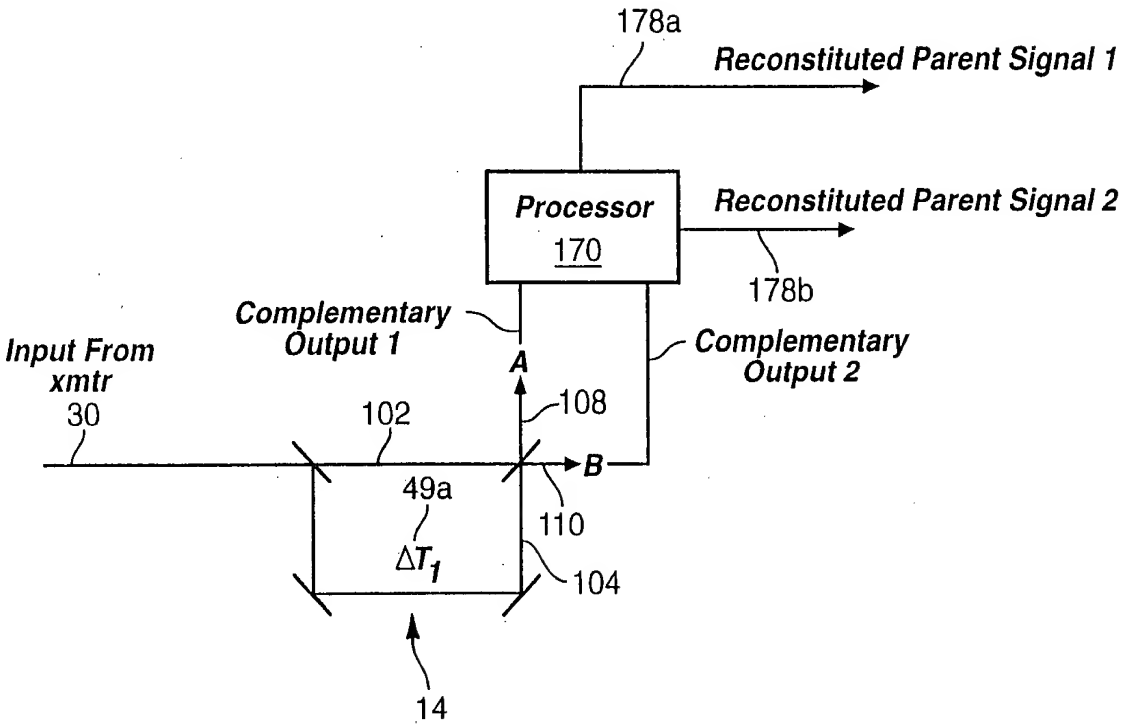


FIG. 31

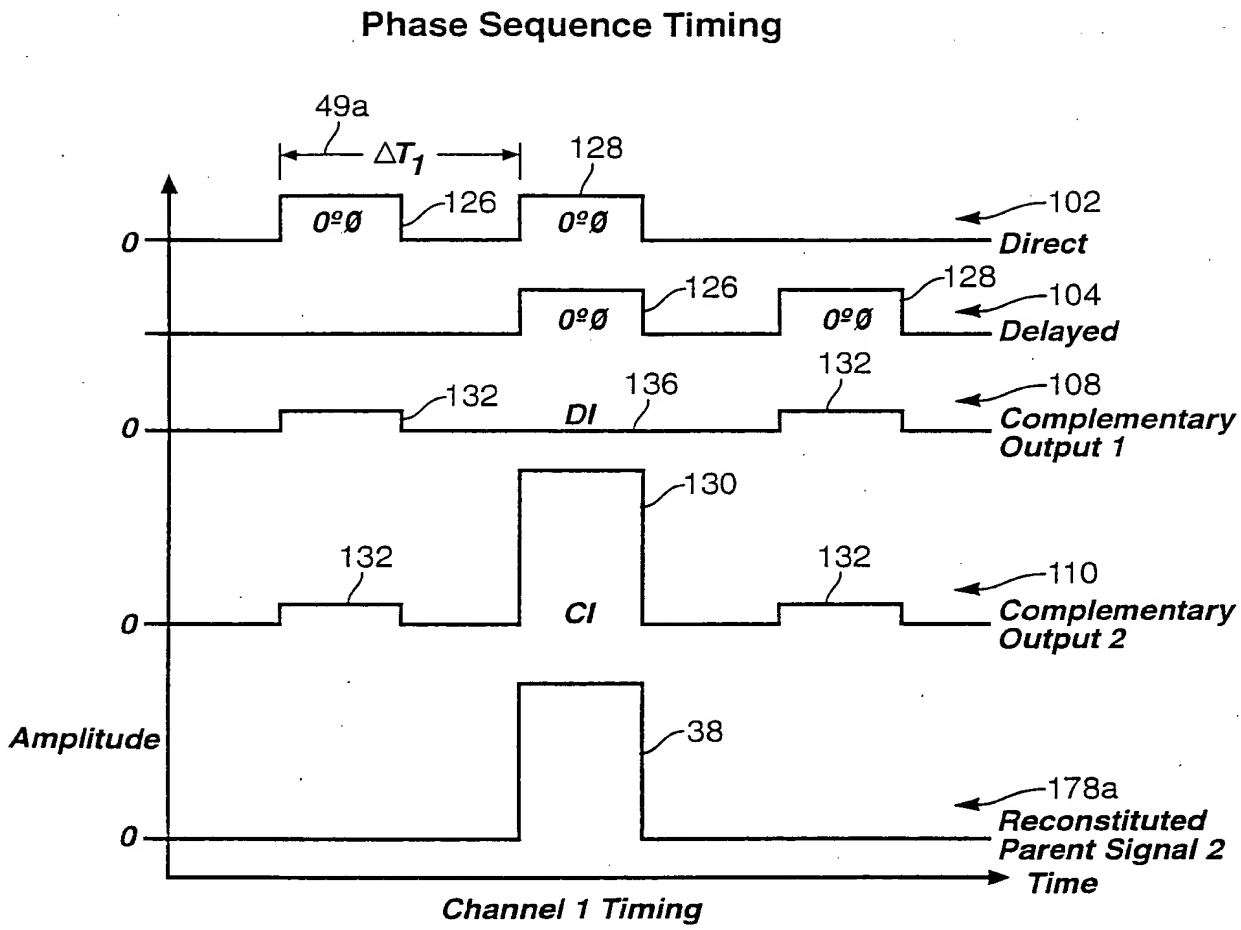

Phase Sequence Timing
49a
ΔT_1
128
126
0ºØ
0ºØ
102
Direct
0
126
128
0ºØ
0ºØ
104
Delayed
132
136
132
DI
108
Complementary Output 1
0
130
132
132
CI
110
Complementary Output 2
0
Amplitude
38
178a
Reconstituted Parent Signal 2
0
Time
Channel 1 Timing

FIG. 32

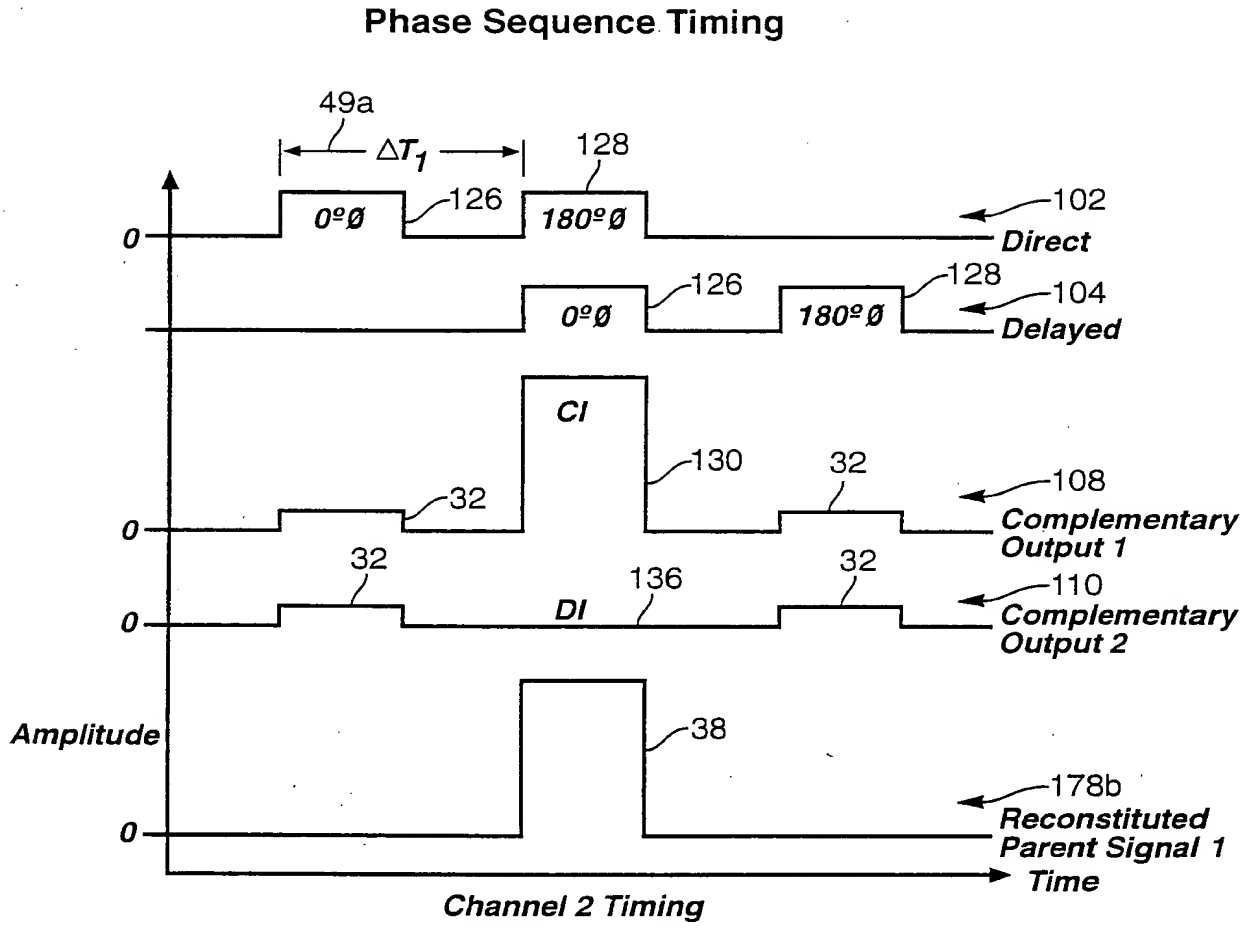

Phase Sequence Timing
49a
ΔT_1
128
126
0º Ø
180º Ø
102
Direct
126
128
104
Delayed
CI
130
32
108
Complementary Output 1
32
136
32
110
Complementary Output 2
Amplitude
38
178b
Reconstituted Parent Signal 1
0
Time
Channel 2 Timing

FIG. 33

Quadrature Encoding/Decoding Apparatus

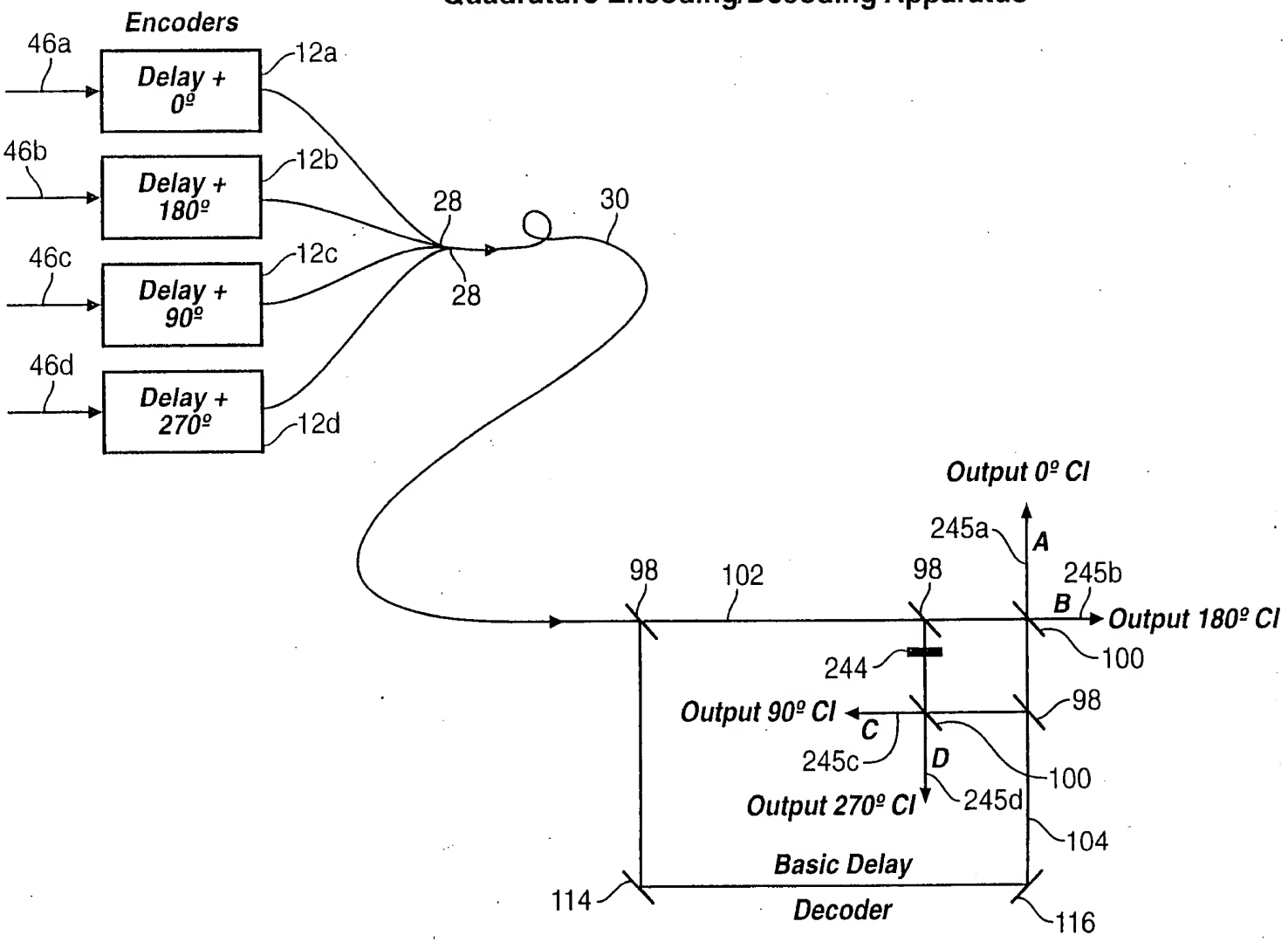


FIG. 34

	Phase of Direct Signal	Phase of Delayed Signal	Quadrature Outputs A	B	C	D
46a → Channel 1	0	0	CI	DI	C = D	
46b → Channel 2	0	180	DI	CI	C = D	
46c → Channel 3	0	90	A = B	CI	DI	
46d → Channel 4	0	270	A = B	DI	CI	

245a 245b 245c 245d

FIG. 35

Quadrature Wave Forms For One Channel

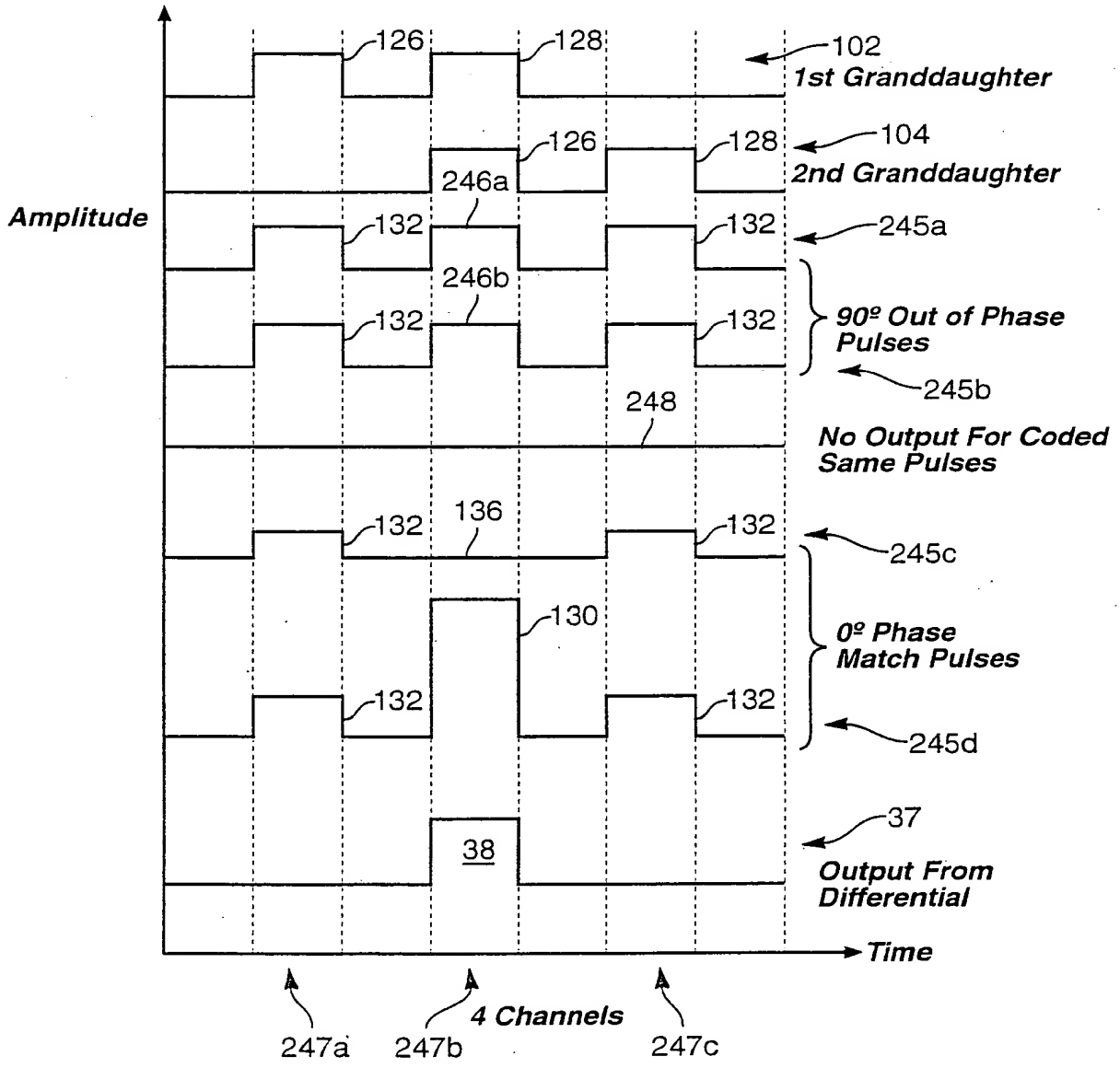


FIG. 36

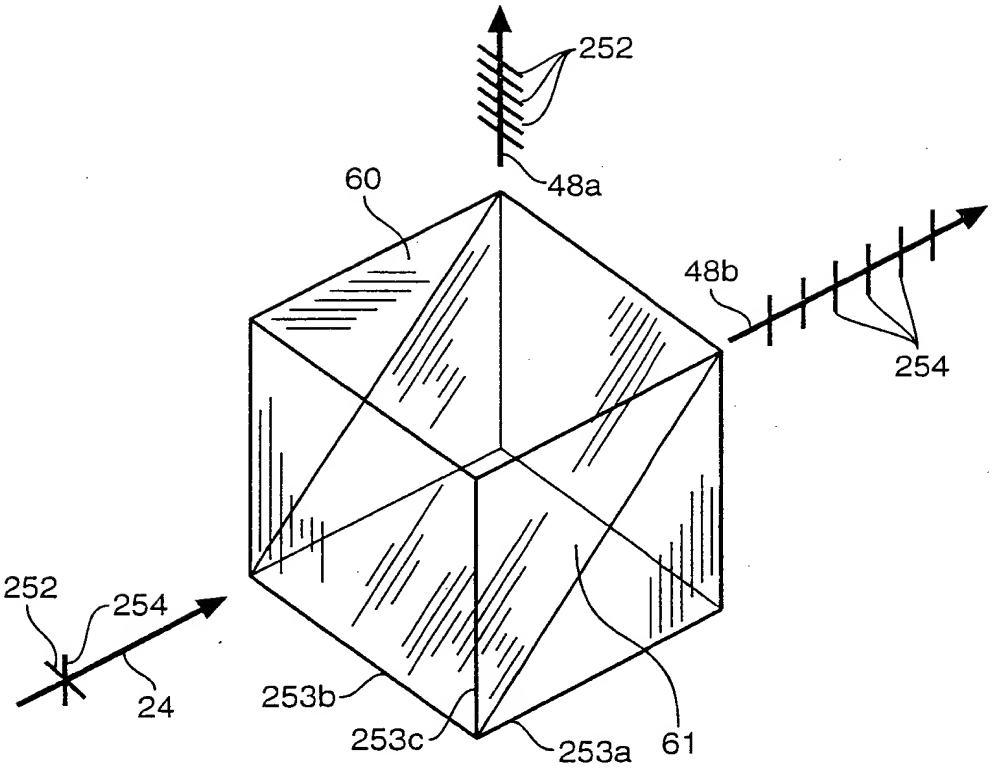


FIG. 37A

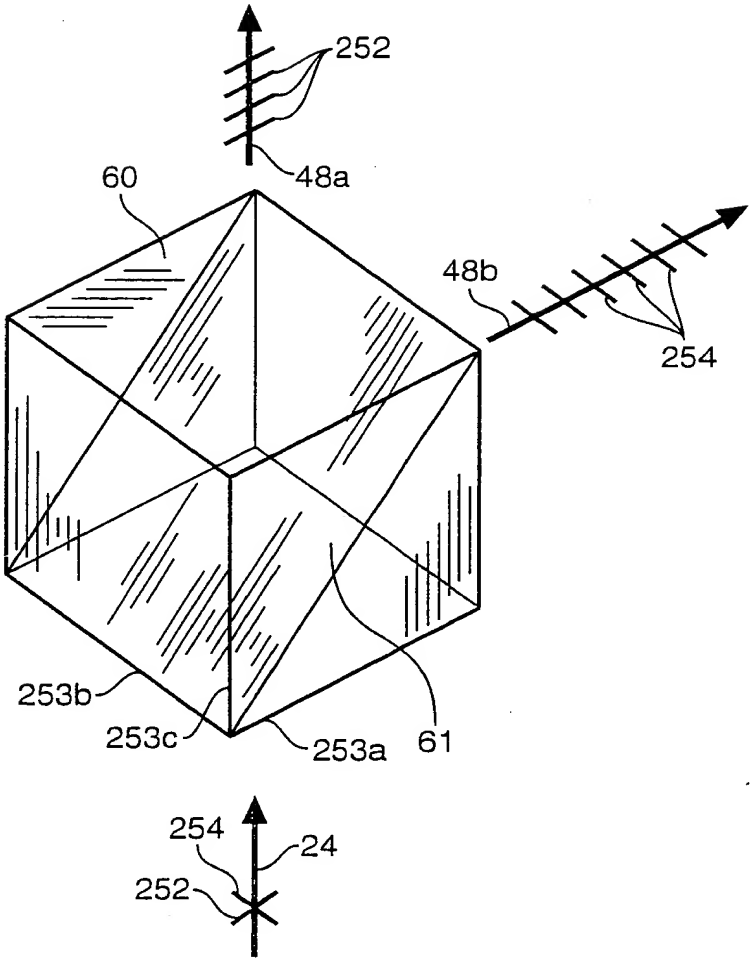
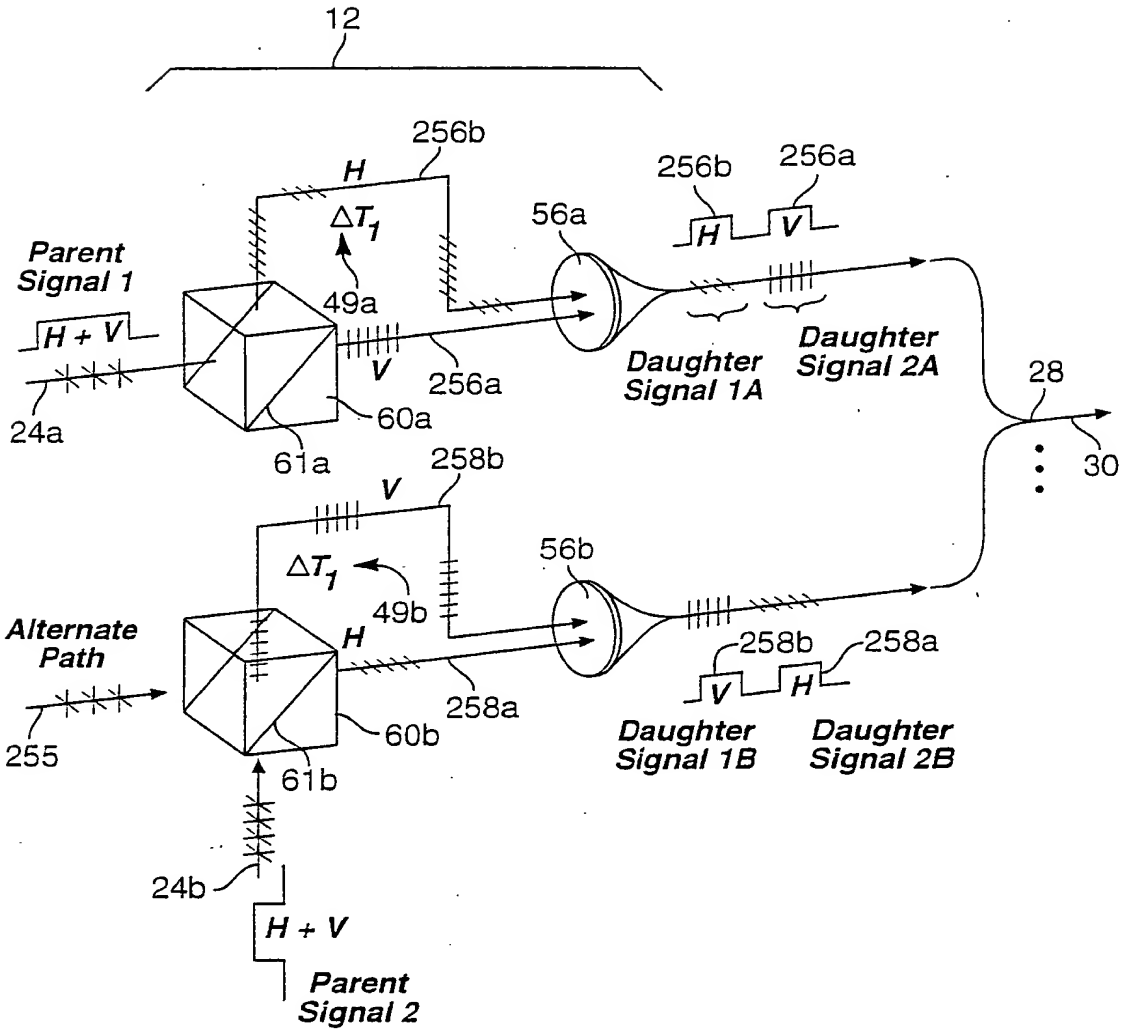
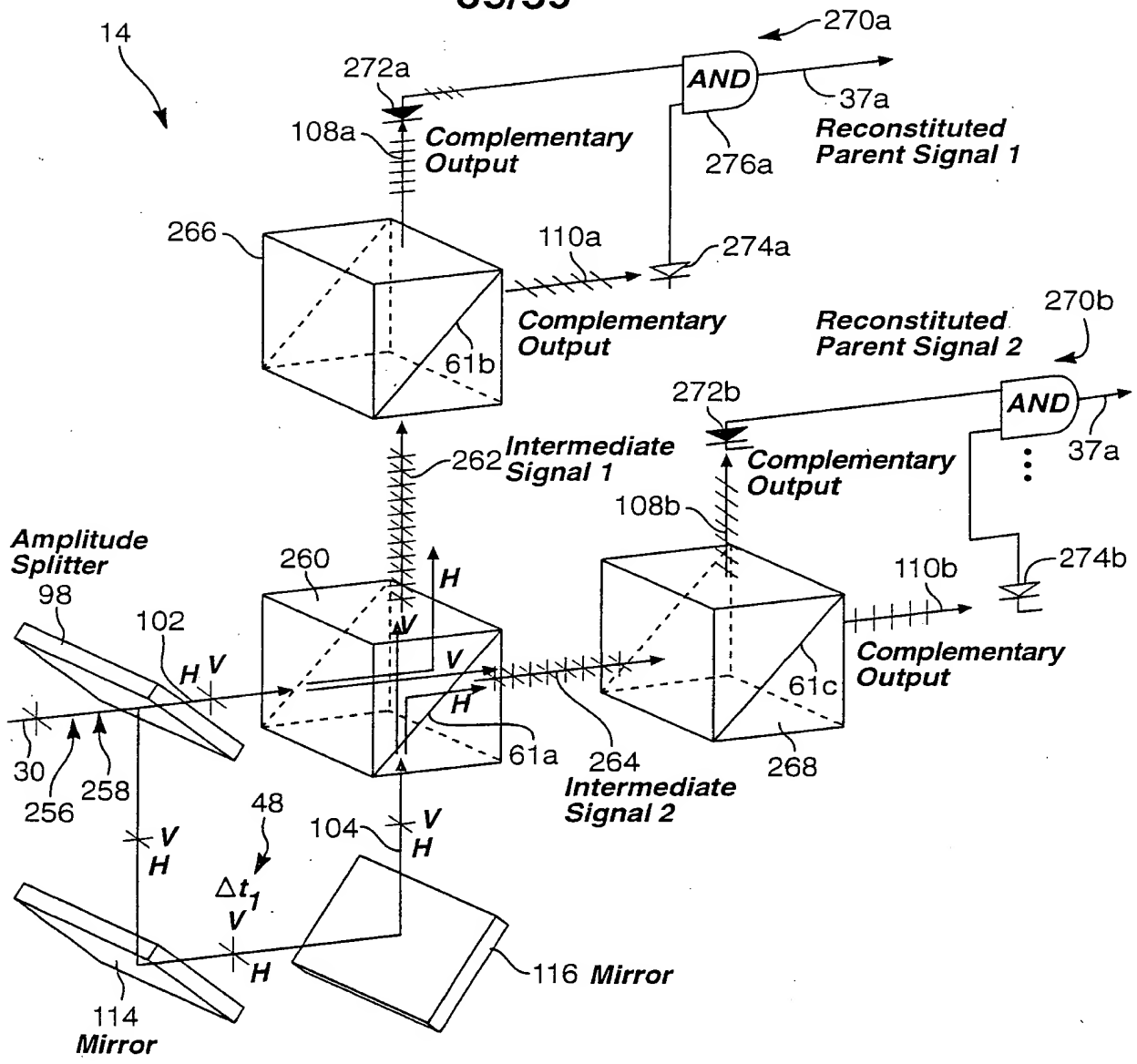


FIG. 37B



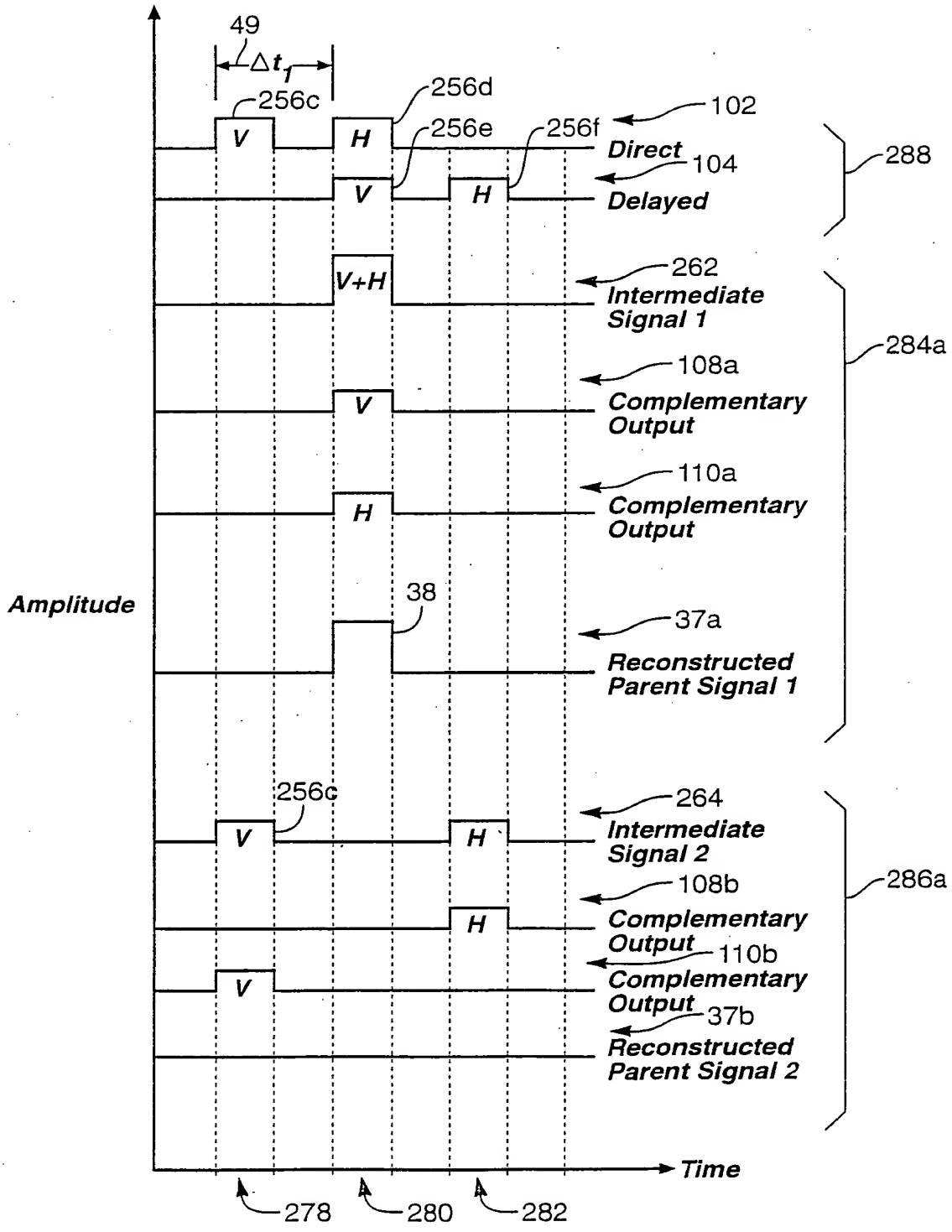
Double Encoder With Polarizations Sequenced to Differentiate 2 Channels Having the Same Time Delay Between Daughter Signals

FIG. 38



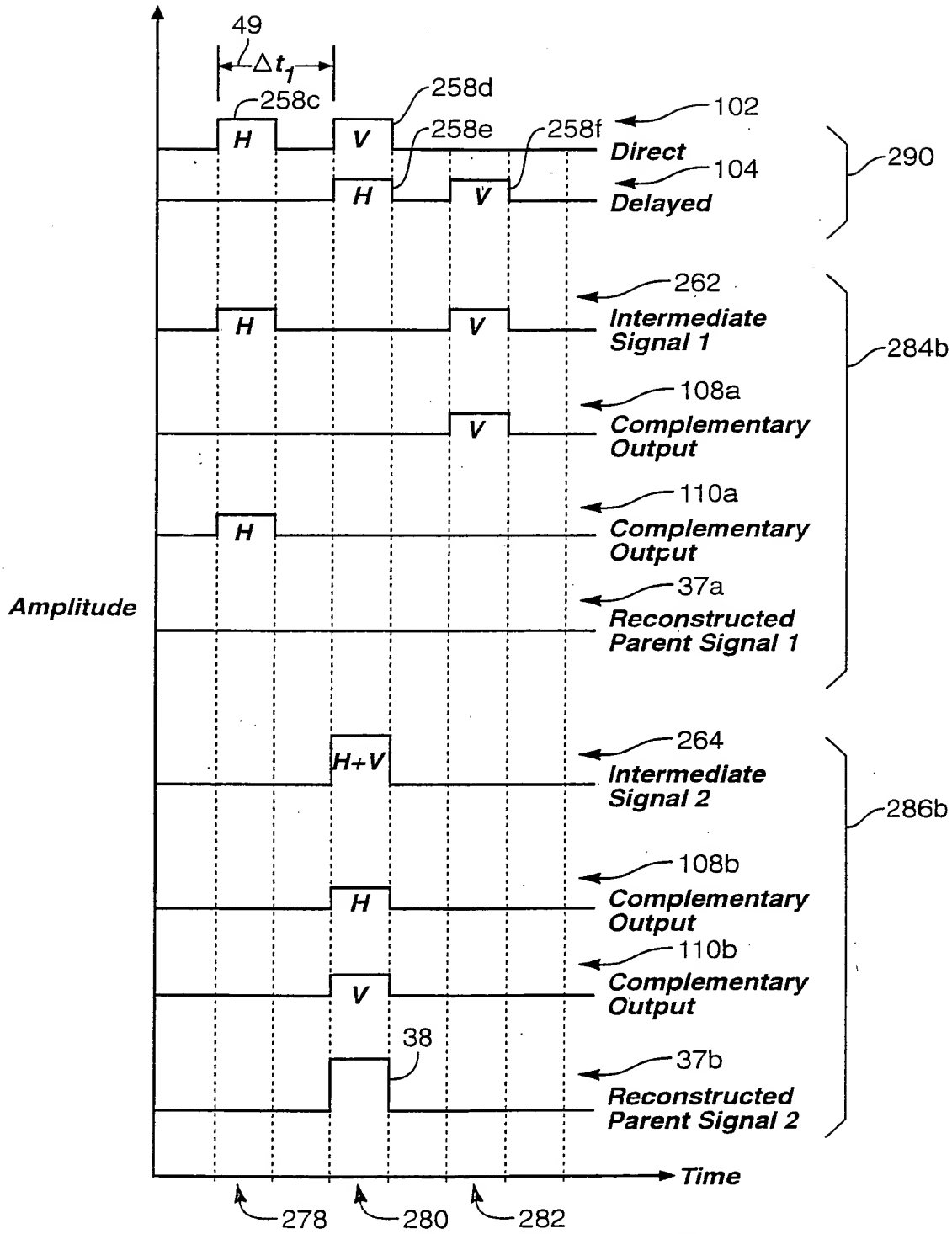
Double Decoder With Polarizations Sequenced to Differentiate 2 Channels Having the Same Time Delay Between Daughter Signals

FIG. 39



Polarization Sequenced Channel 1 Timing

FIG. 40



Polarization Sequenced Channel 1 Timing

FIG. 41

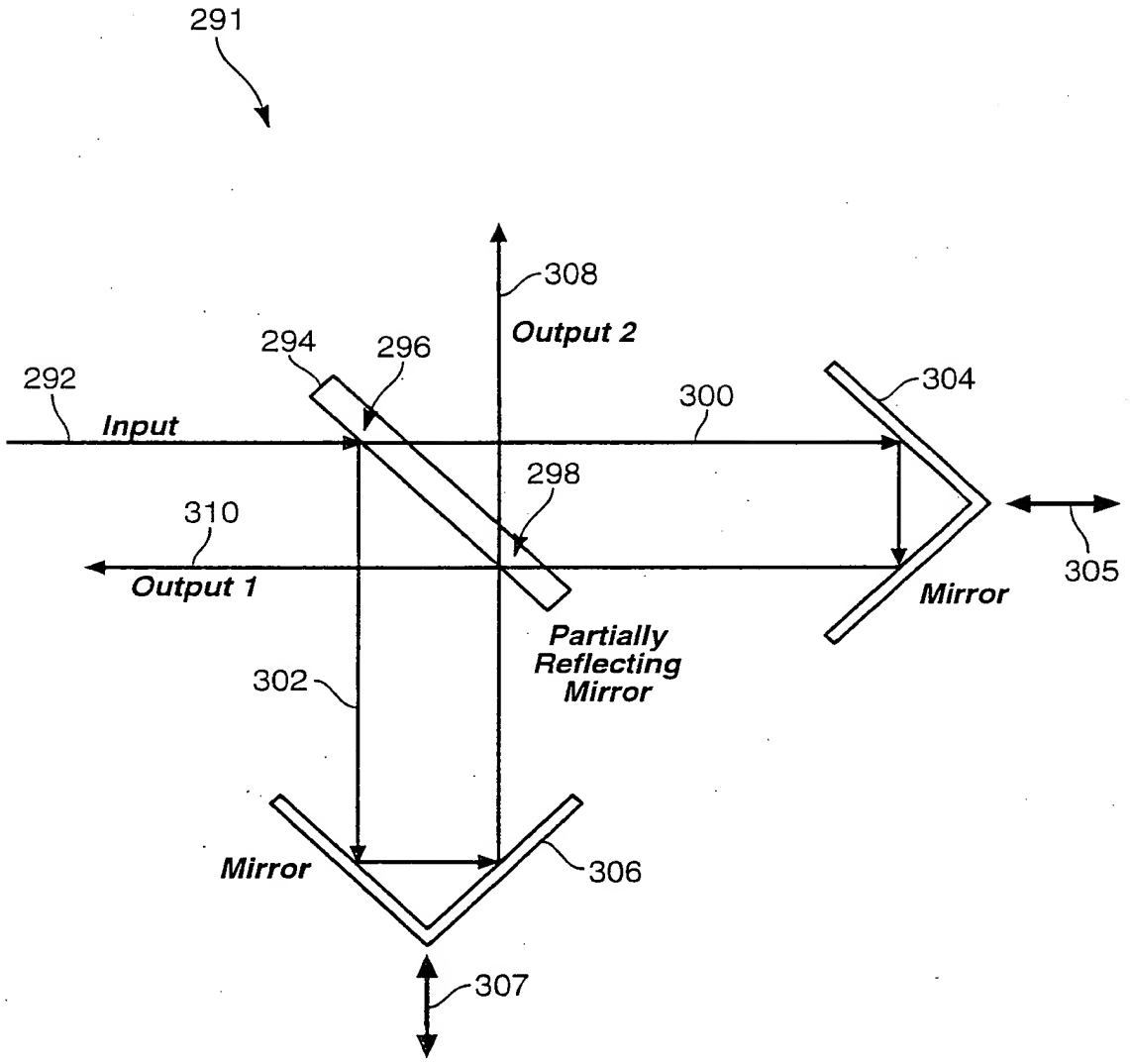

291
308
Output 2
294
296
292
Input
300
304
298
310
Output 1
305
Mirror
Partially
Reflecting
Mirror
302
Mirror
306
307

FIG. 42

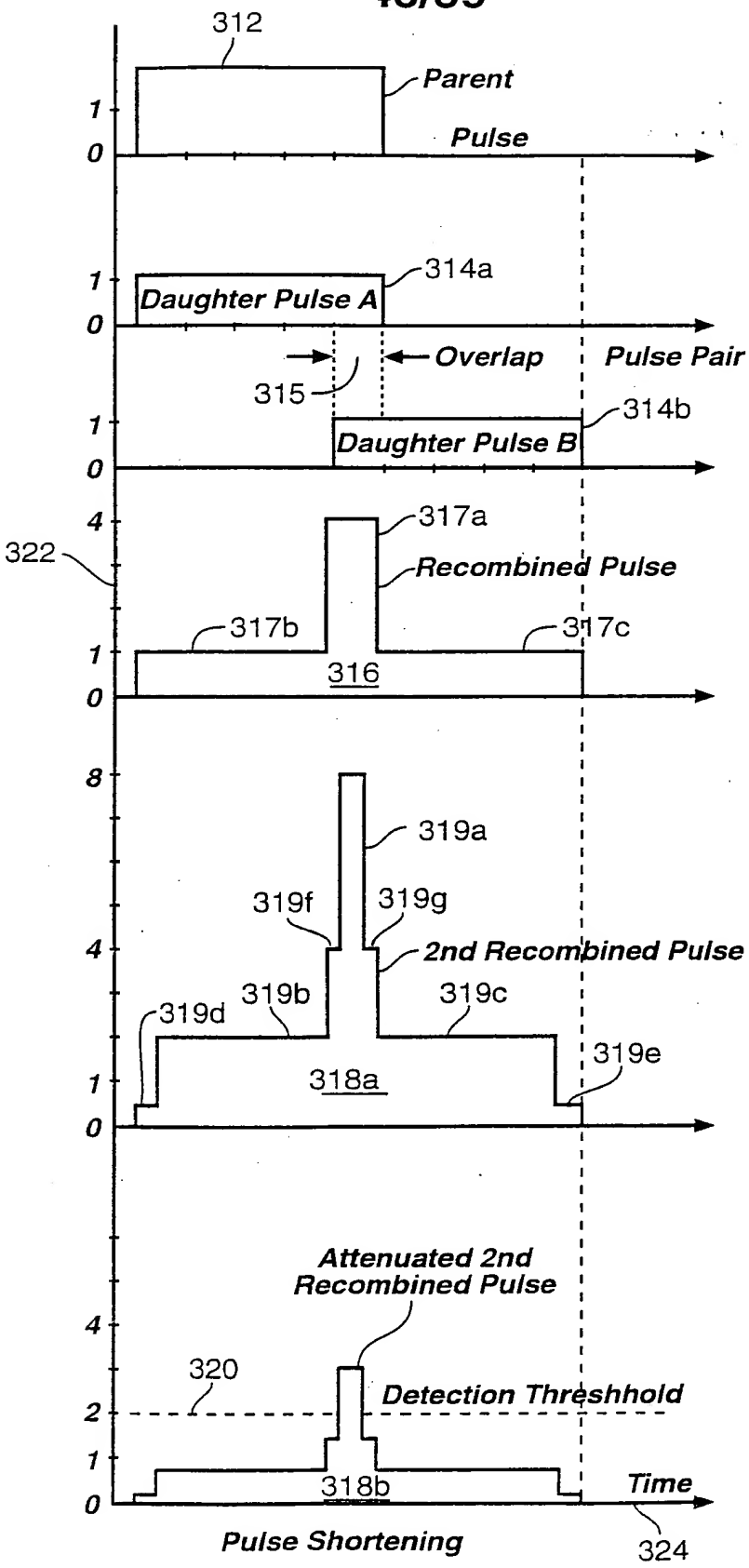

312
Parent
Pulse
1
0
Daughter Pulse A
314a
Overlap
Pulse Pair
315
Daughter Pulse B
314b
4
322
317a
Recombined Pulse
317b
317c
316
8
319a
319f
319g
2nd Recombined Pulse
319b
319c
319d
319e
318a
Attenuated 2nd
Recombined Pulse
320
Detection Threshhold
2
318b
Time
Pulse Shortening
324

FIG. 43

WO 98/51990 PCT/US98/09860

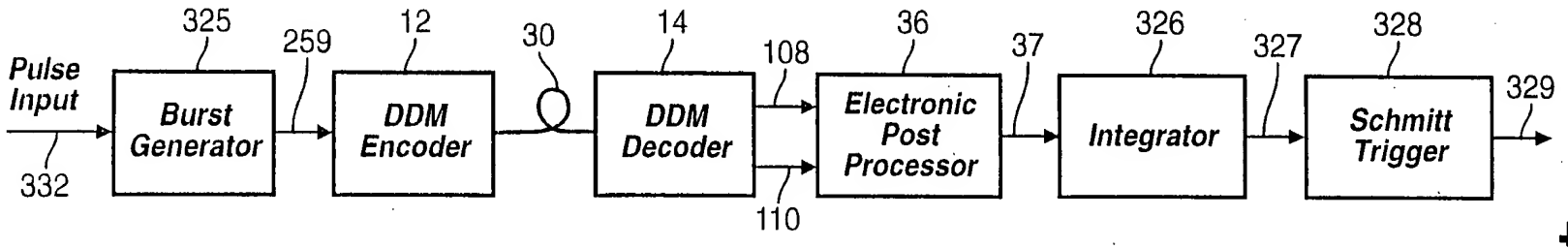


FIG. 44

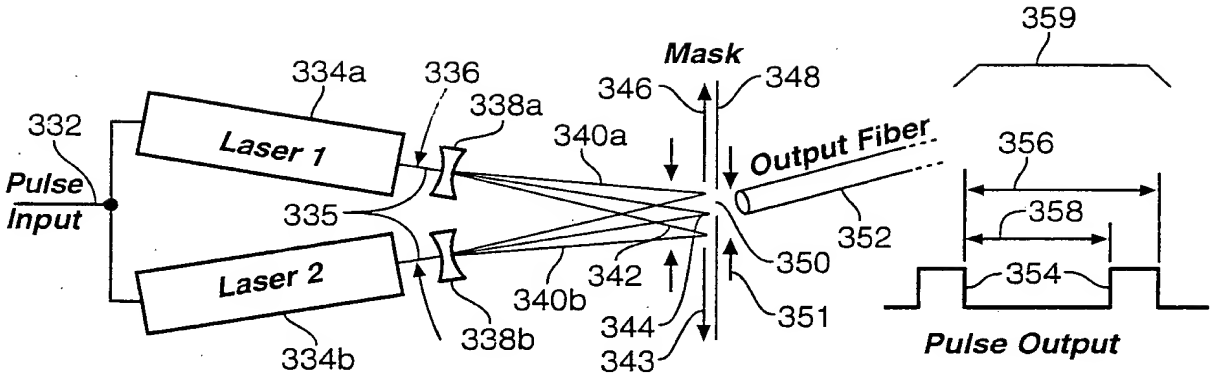

359
Mask
334a
336
346
348
338a
340a
332
Laser 1
Output Fiber
356
Pulse
Input
335
358
352
Laser 2
342
350
340b
354
344
351
338b
334b
343
Pulse Output

FIG. 45

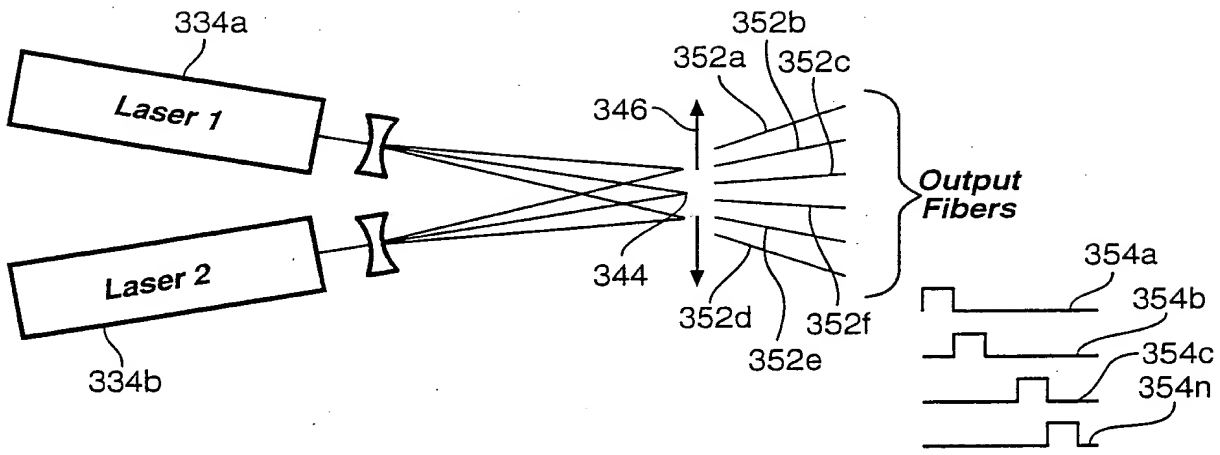

334a
Laser 1
Laser 2
334b
346
344
352a
352b
352c
352d
352e
352f
Output Fibers
354a
354b
354c
354n

FIG. 46

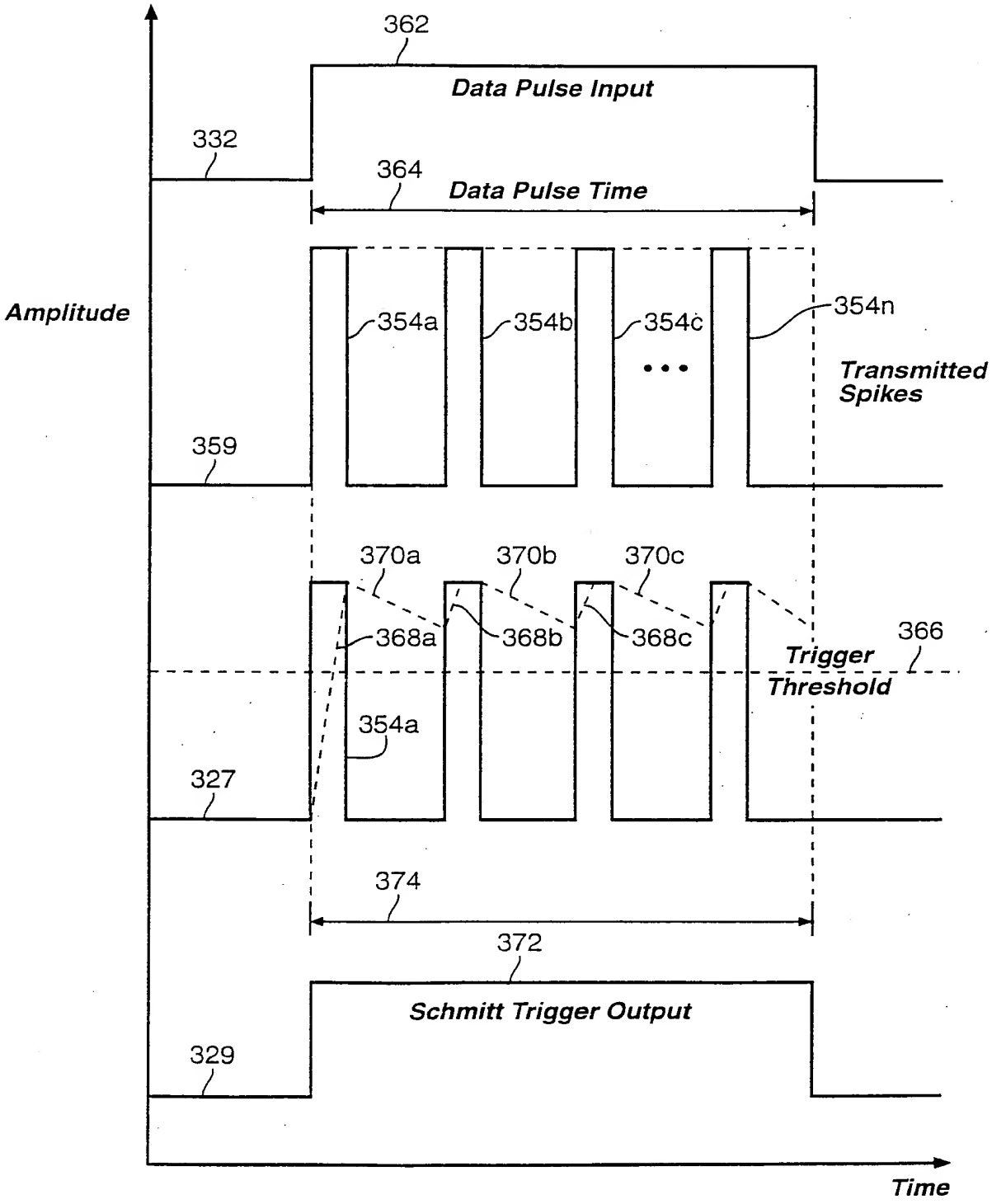

362
Data Pulse Input
332
364
Data Pulse Time
Amplitude
354a
354b
354c
354n
Transmitted Spikes
359
370a
370b
370c
368a
368b
368c
366
Trigger Threshold
354a
327
374
372
Schmitt Trigger Output
329
Time

FIG. 47

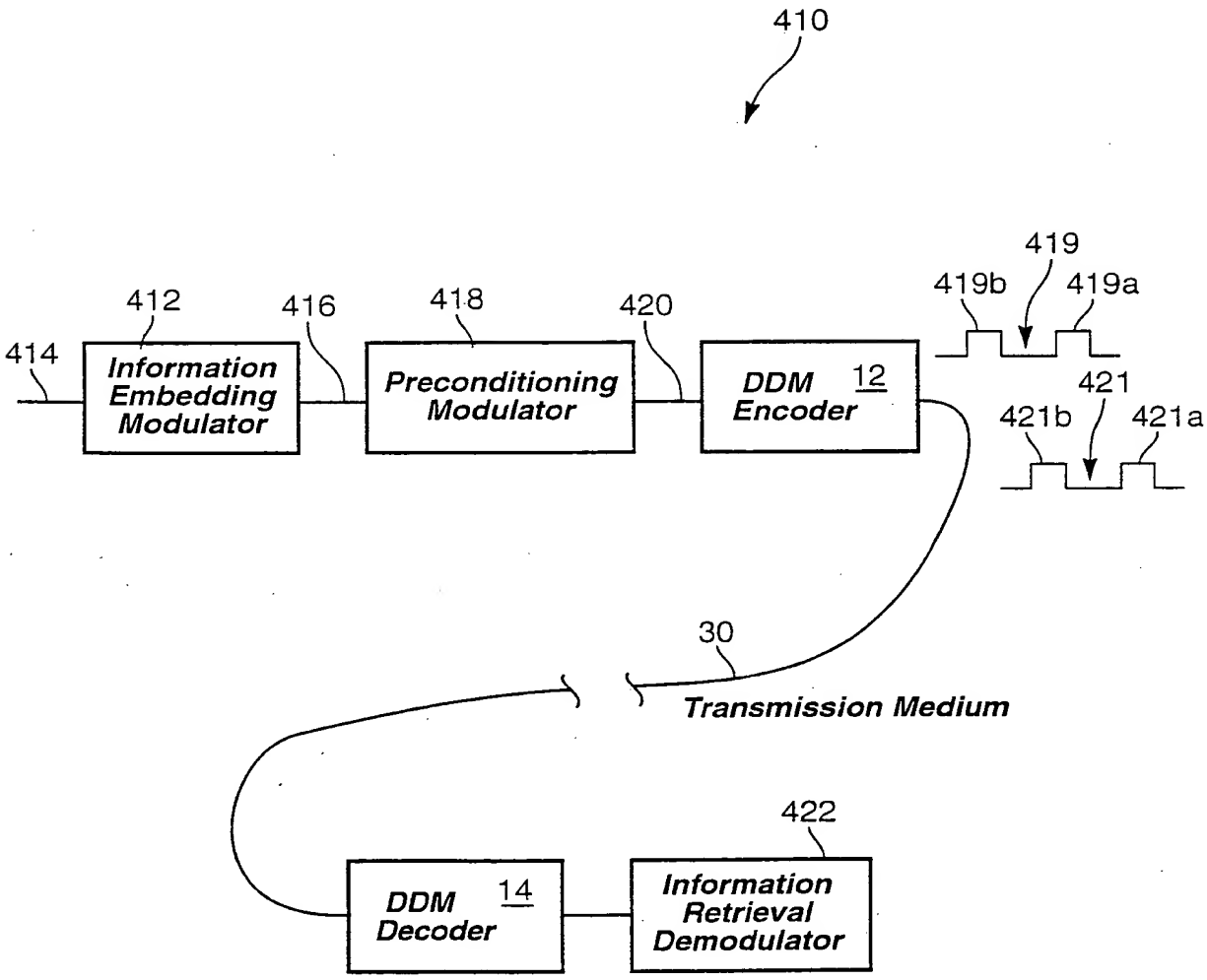

410
414
412
Information Embedding Modulator
416
418
Preconditioning Modulator
420
DDM Encoder 12
419
419b
419a
421
421b
421a
30
Transmission Medium
422
DDM Decoder 14
Information Retrieval Demodulator

FIG. 48

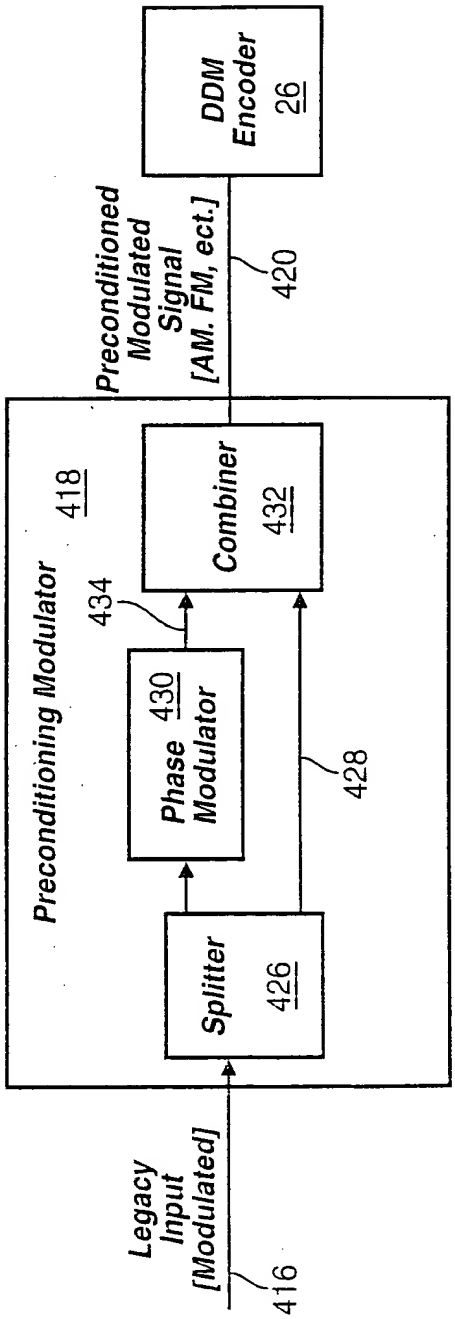

Legacy Input [Modulated]
416
Preconditioning Modulator
418
Splitter
426
Phase Modulator
430
434
Combiner
432
428
Preconditioned Modulated Signal [AM. FM, ect.]
420
DDM Encoder
26

FIG. 49

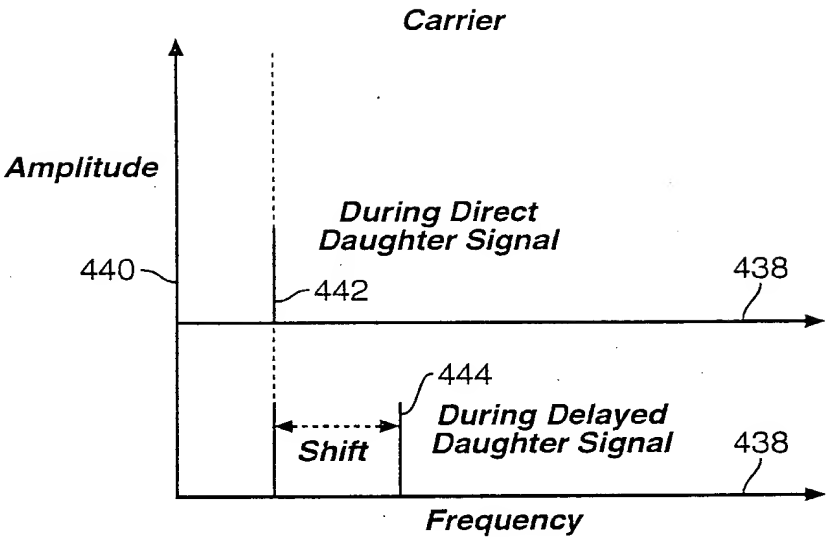

Carrier
Amplitude
During Direct
Daughter Signal
440
442
438
444
During Delayed
Daughter Signal
Shift
438
Frequency

FIG. 50

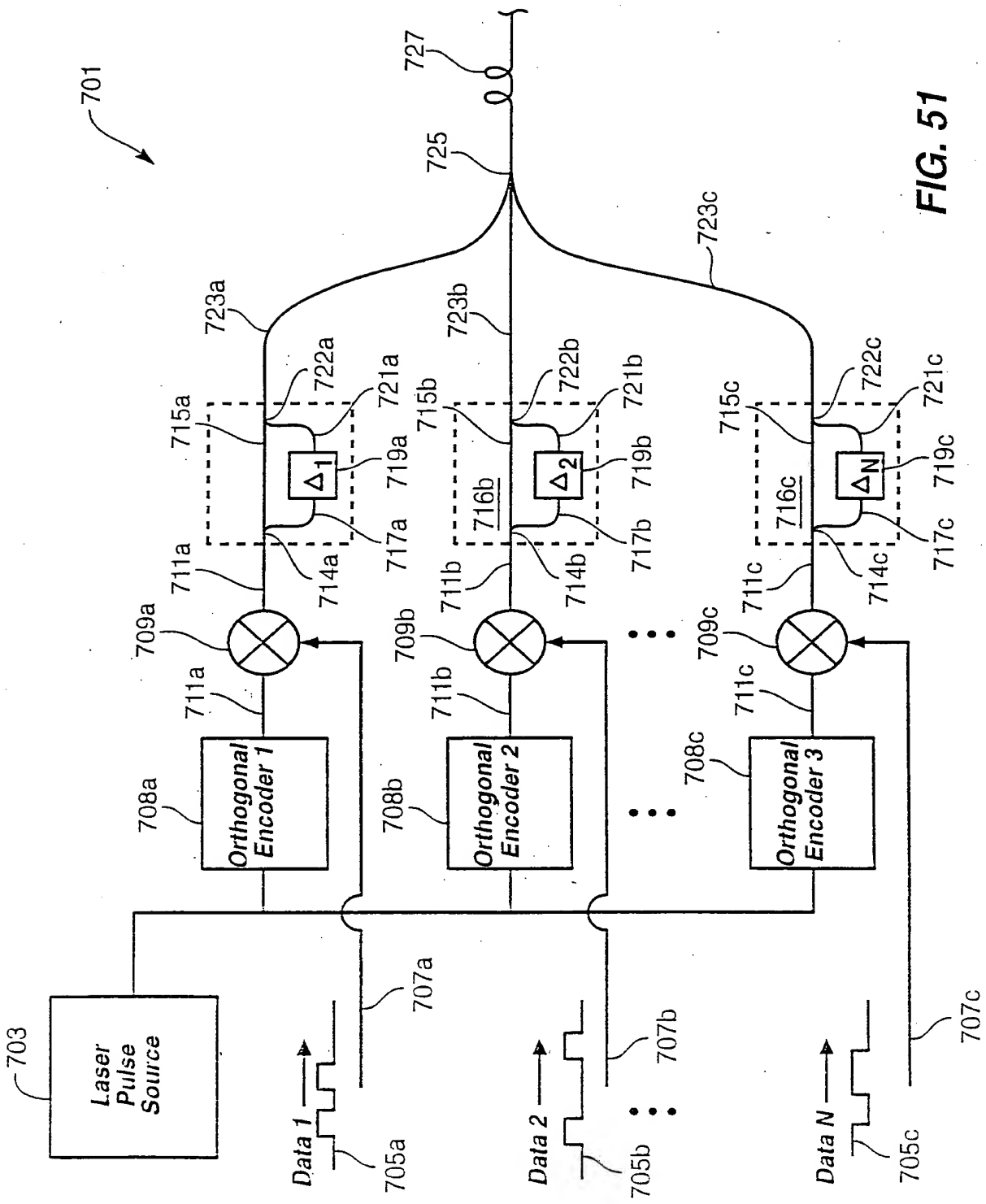

701
727
725
723a
723b
723c
715a
715b
715c
722a
722b
722c
721a
721b
721c
719a
719b
719c
716b
716c
717a
717b
717c
714a
714b
714c
711a
711b
711c
709a
709b
709c
708a
708b
708c
Orthogonal Encoder 1
Orthogonal Encoder 2
Orthogonal Encoder 3
Δ1
Δ2
ΔN
703
Laser Pulse Source
Data 1
Data 2
Data N
705a
705b
705c
707a
707b
707c

FIG. 51

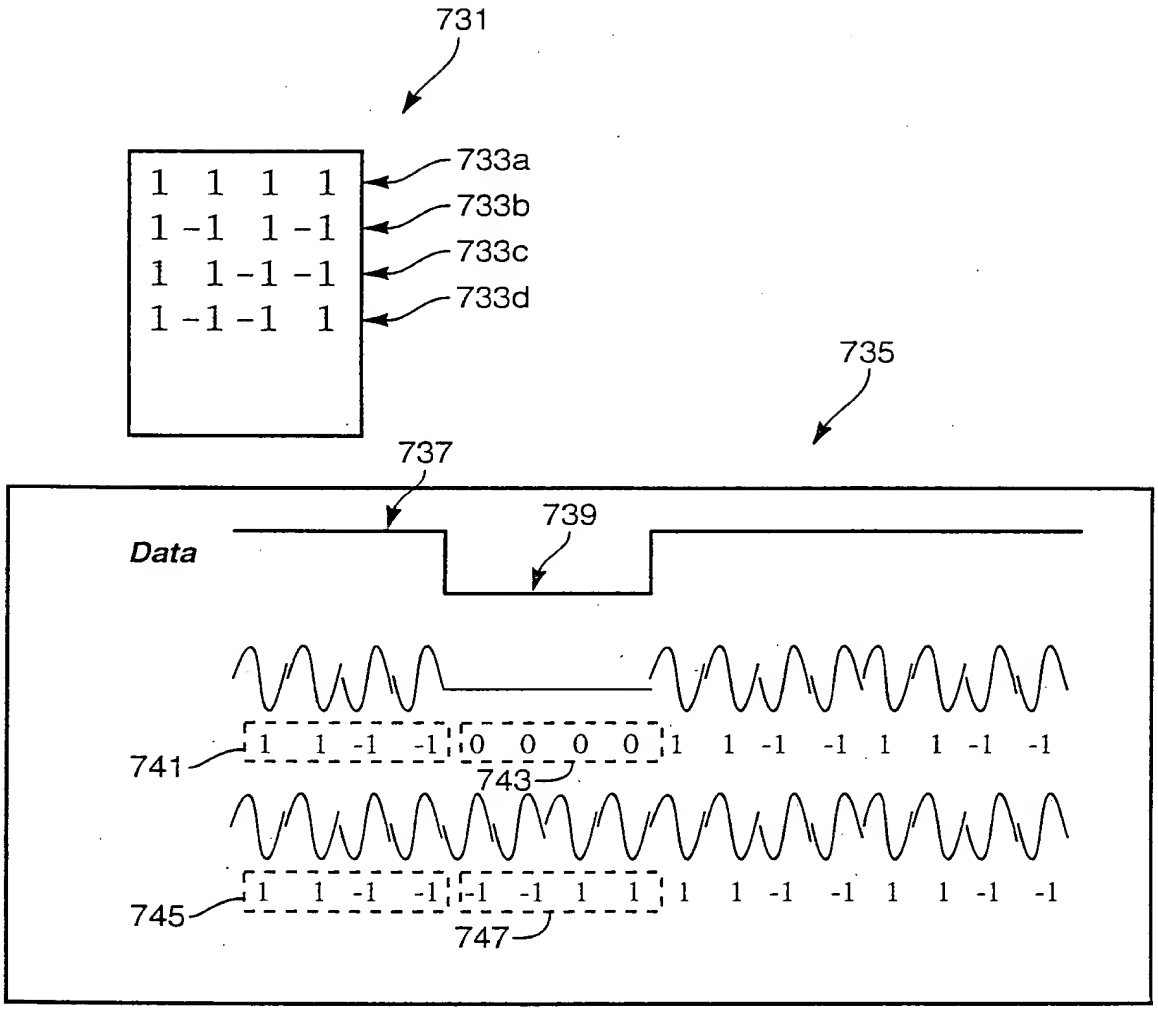

731
1 1 1 1
1 -1 1 -1
1 1 -1 -1
1 -1 -1 1
733a
733b
733c
733d
735
737
739
Data
741
1 1 -1 -1 0 0 0 0 1 1 -1 -1 1 1 -1 -1
743
745
1 1 -1 -1 -1 -1 1 1 1 1 -1 -1 1 1 -1 -1
747

FIG. 52

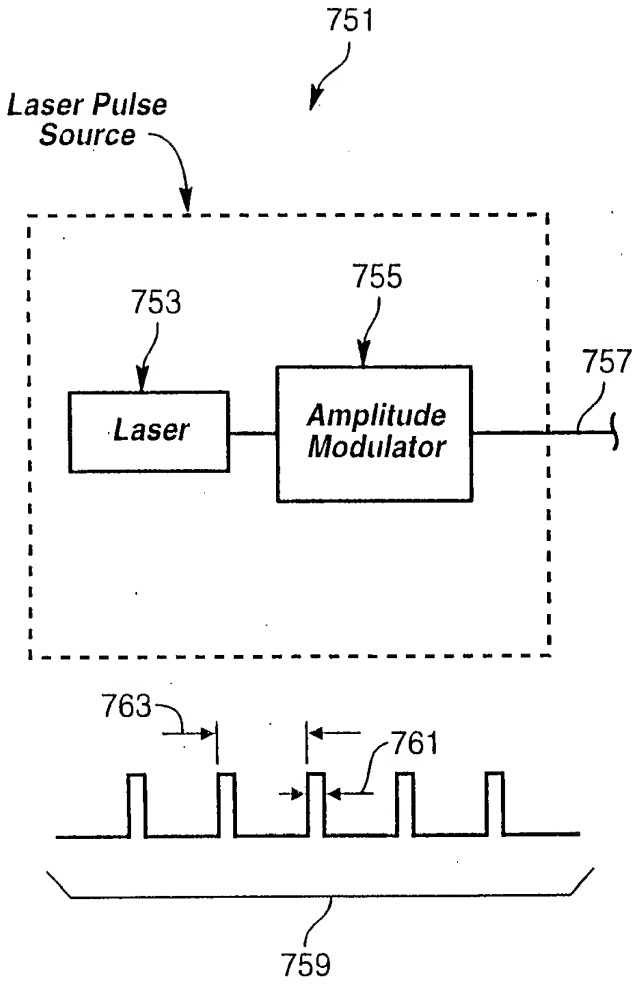

751
Laser Pulse Source
753
755
757
Laser
Amplitude Modulator
763
761
759

FIG. 53

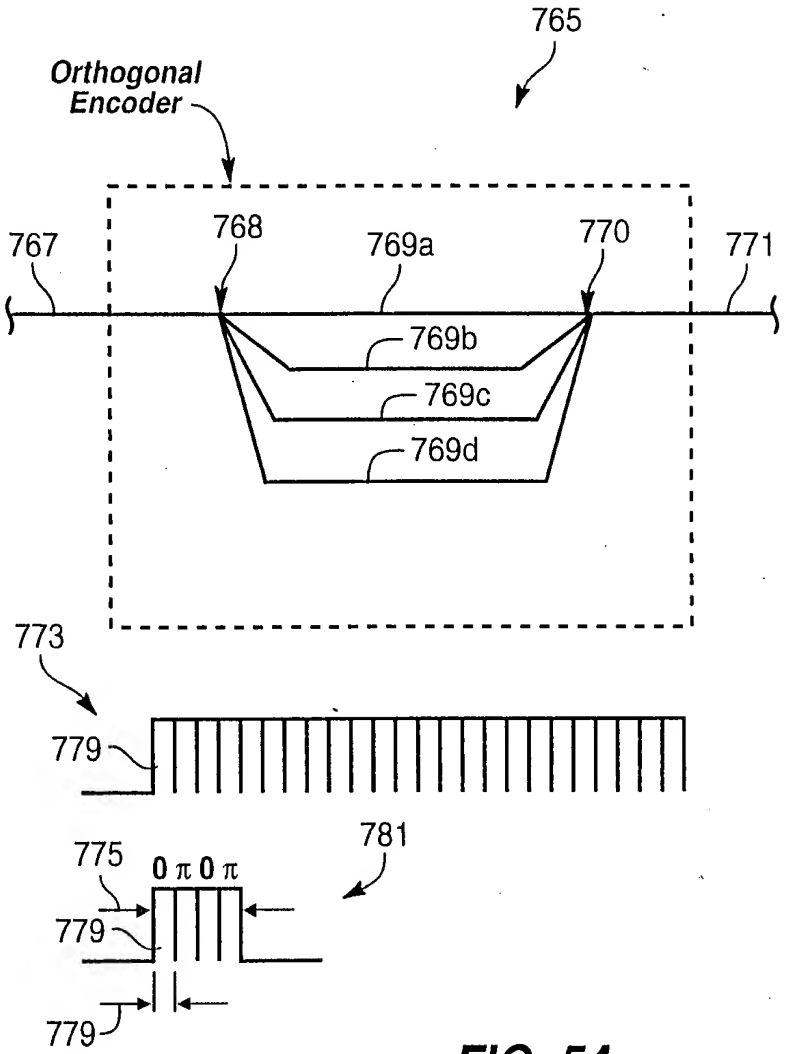
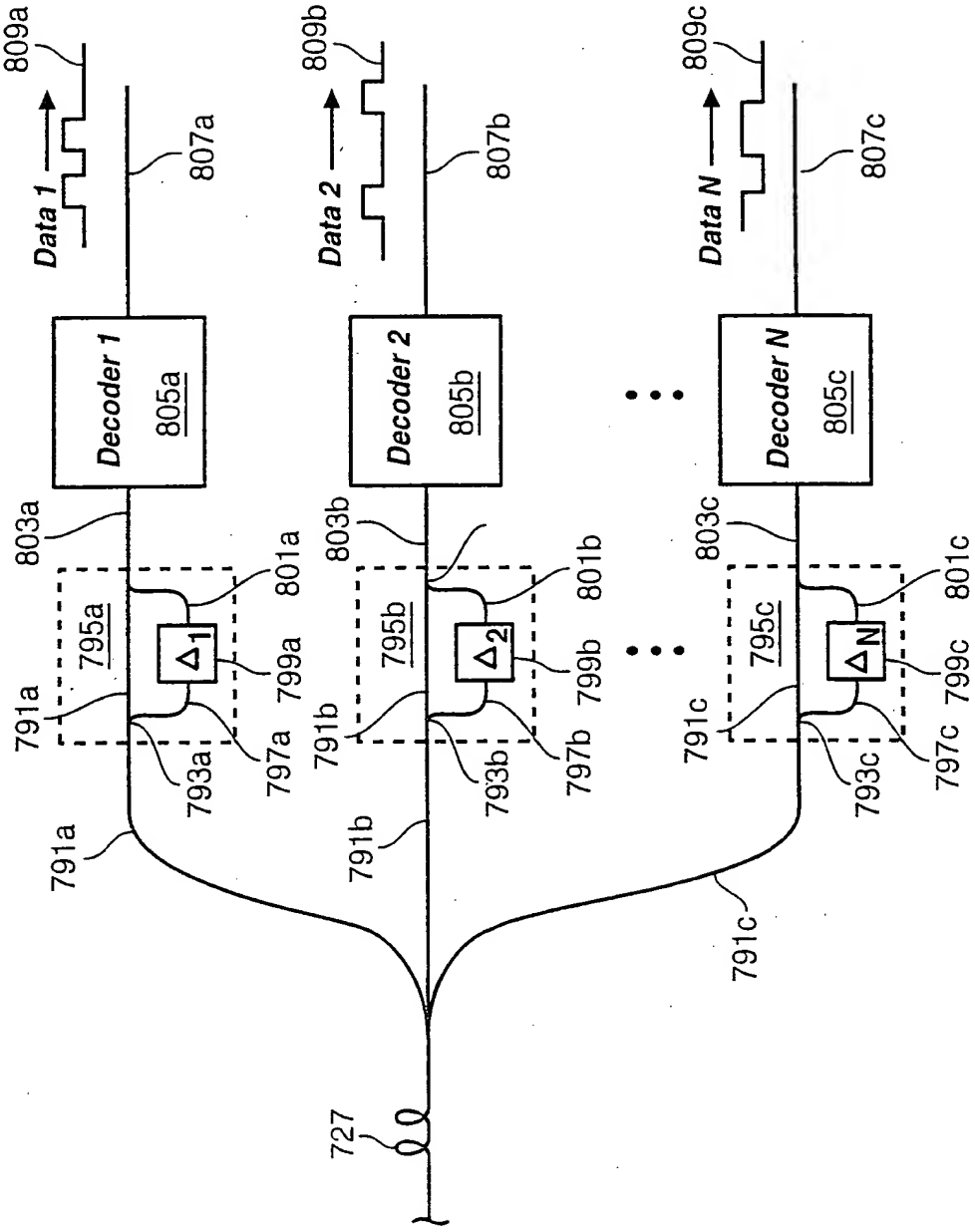

765
Orthogonal Encoder
767
768
769a
770
771
769b
769c
769d
773
779
781
775
0 π 0 π
779
779

FIG. 54


809a
Data 1
807a
Decoder 1
805a
803a
795a
801a
791a
Δ1
799a
793a
797a
791a
809b
Data 2
807b
Decoder 2
805b
803b
795b
801b
791b
Δ2
799b
793b
797b
791b
809c
Data N
807c
Decoder N
805c
803c
795c
801c
791c
ΔN
799c
793c
797c
791c
727

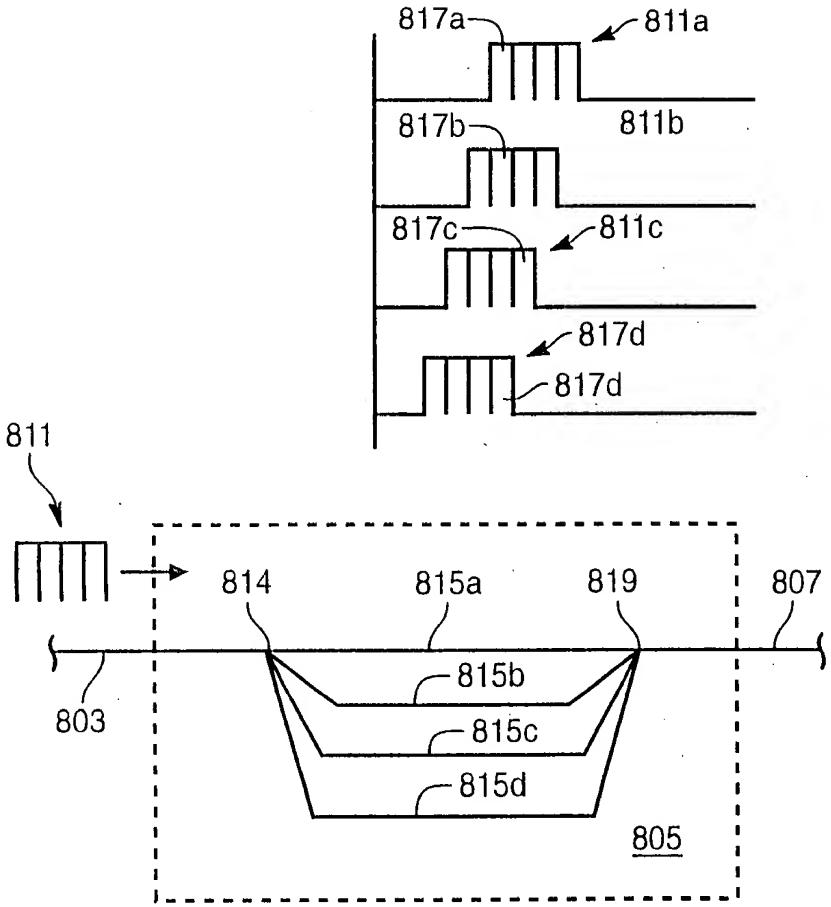

817a
811a
811b
817b
817c
811c
817d
817d
811
814
815a
819
807
803
815b
815c
815d
805

FIG. 56

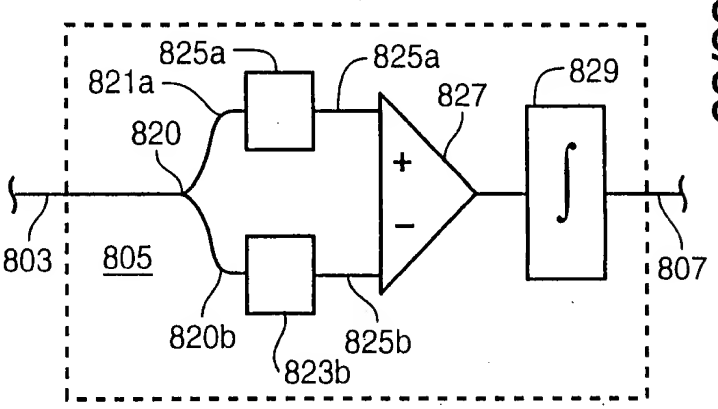

825a
825a
821a
827
829
820
+
−
803
805
807
820b
825b
823b

FIG. 57

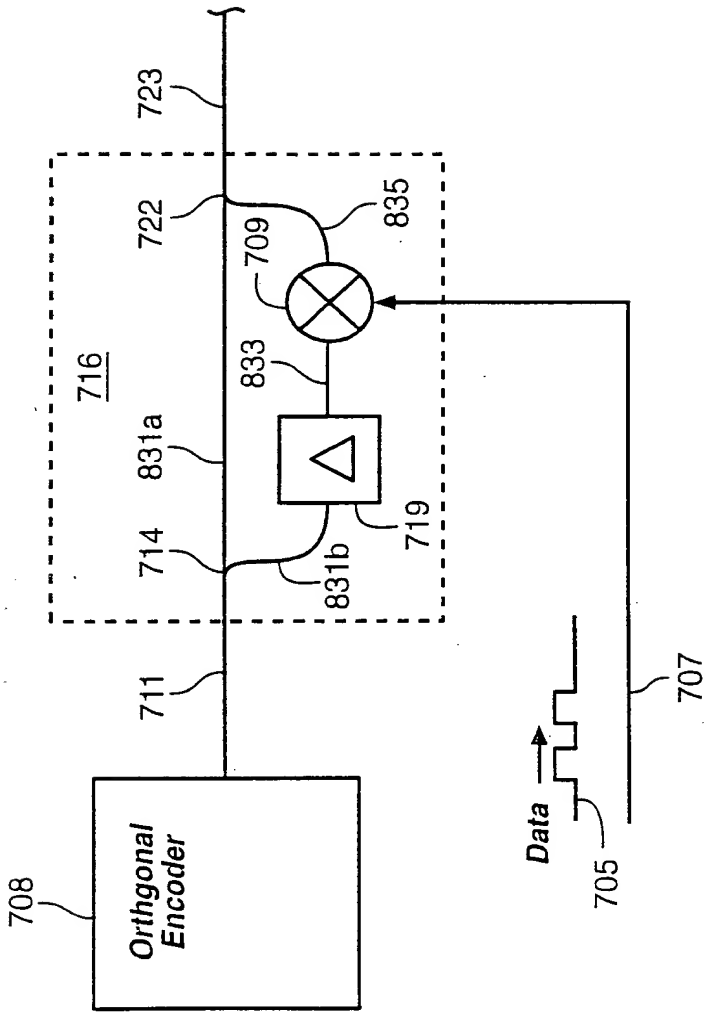

708
Orthgonal Encoder
711
714
831a
716
831b
719
722
723
709
833
835
707
Data
705

FIG. 58

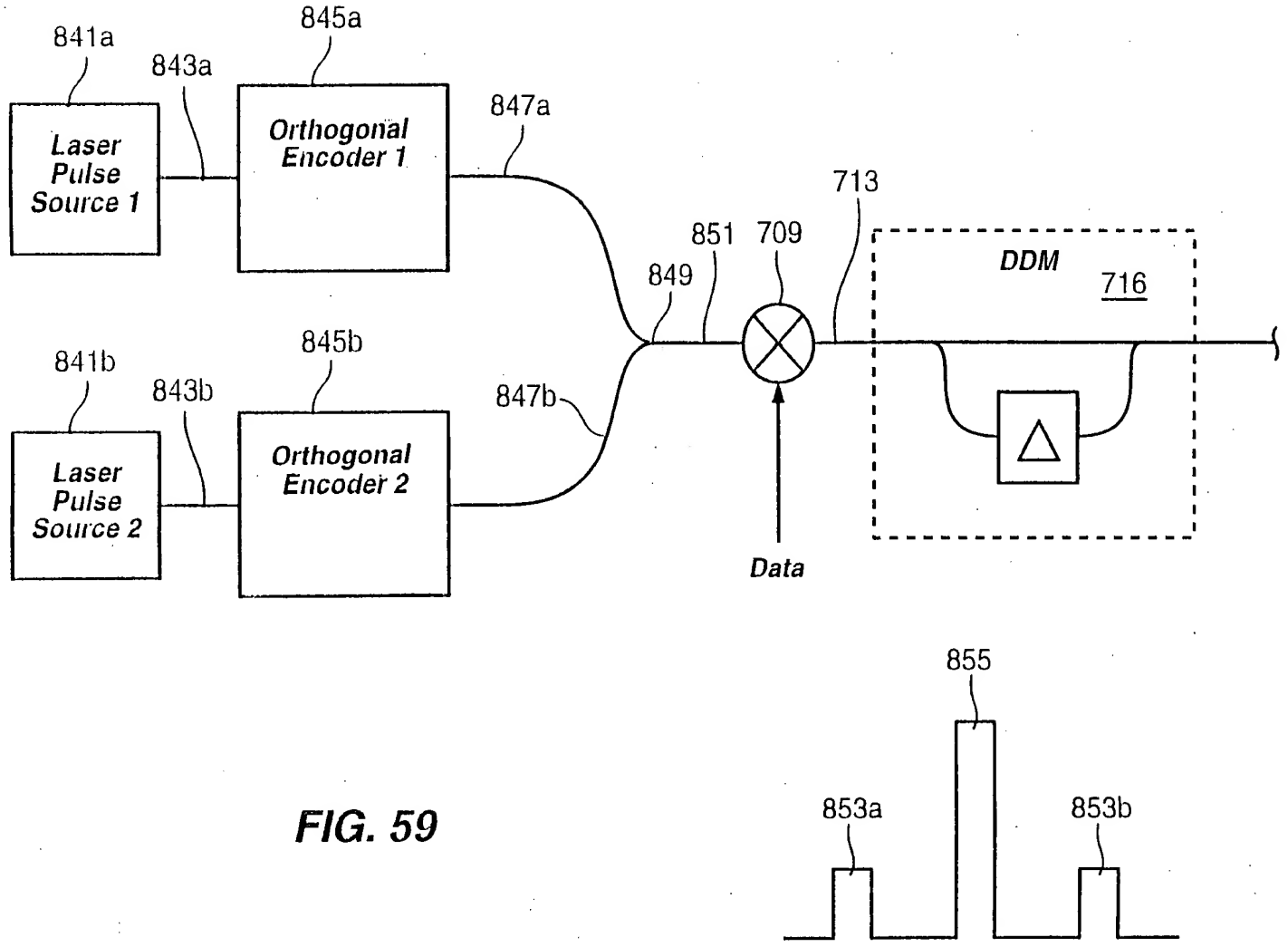

841a
843a
845a
Laser Pulse Source 1
Orthogonal Encoder 1
847a
713
851
709
849
DDM
716
841b
843b
845b
847b
Laser Pulse Source 2
Orthogonal Encoder 2
Data
855
853a
853b

FIG. 59

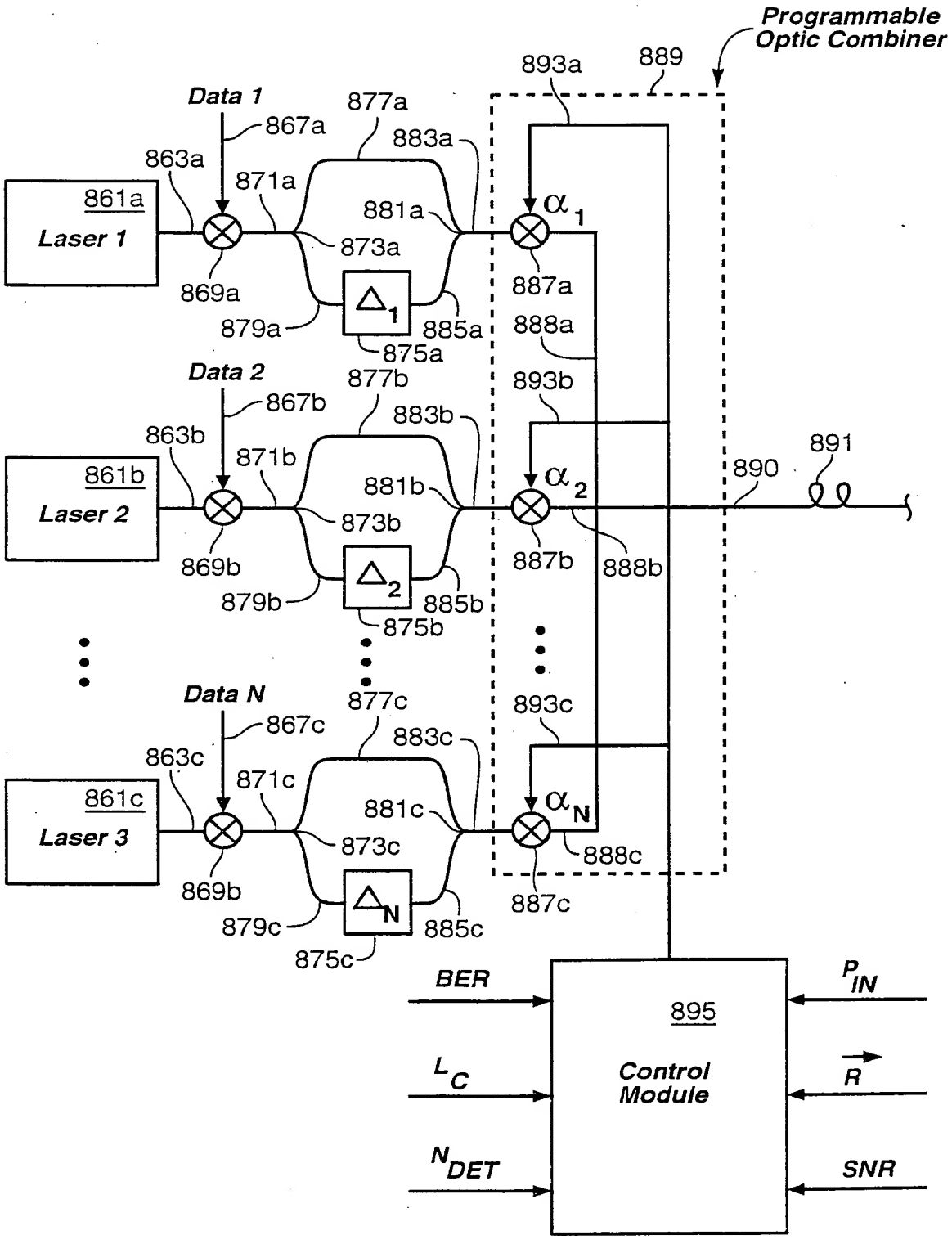

Programmable Optic Combiner
889
893a
Data 1
867a
877a
883a
863a
871a
881a
861a
Laser 1
873a
869a
879a
885a
875a
887a
888a
Data 2
867b
877b
893b
883b
863b
871b
881b
861b
Laser 2
873b
869b
879b
885b
875b
887b
888b
890
891
Data N
867c
877c
893c
883c
863c
871c
881c
861c
Laser 3
873c
869b
879c
885c
875c
887c
888c
BER
895
Control Module
SNR

FIG. 60

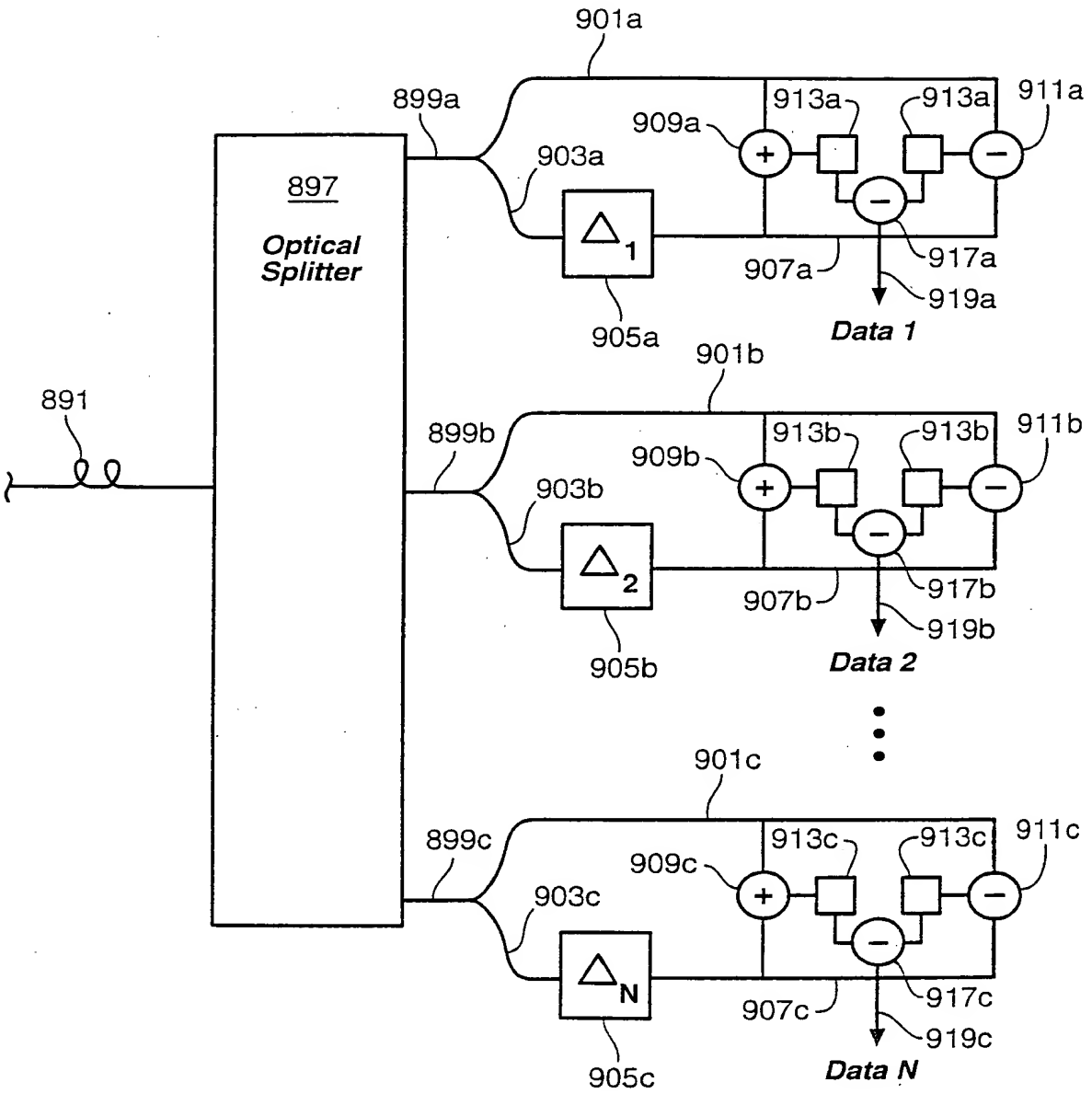

901a
899a
913a
913a
911a
909a
903a
897
Optical Splitter
Δ1
907a
917a
919a
905a
Data 1
901b
891
899b
913b
913b
911b
909b
903b
Δ2
907b
917b
919b
905b
Data 2
901c
899c
913c
913c
911c
909c
903c
ΔN
907c
917c
919c
905c
Data N

FIG. 61